FOOD TECHNOLOGY

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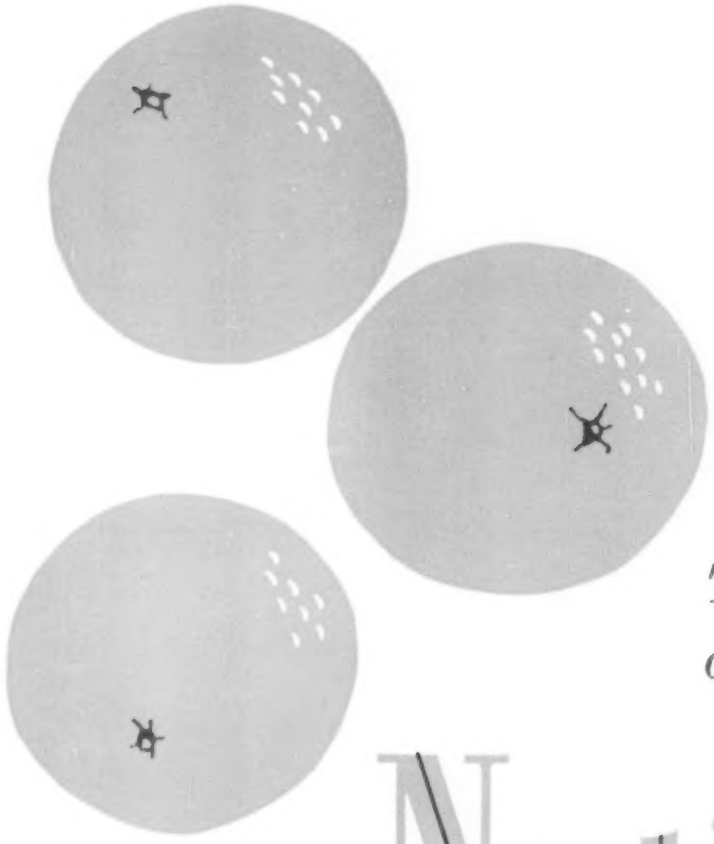

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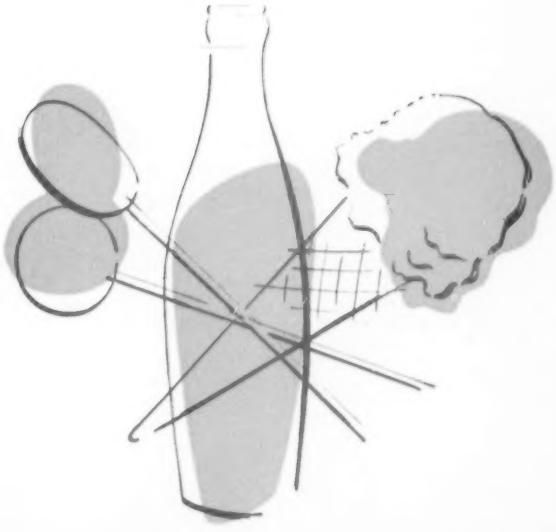

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Affairs of the Institute

Masters and Doctors in Food Technology
News of the Regional Sections
Personnel
Selected Abstracts
Books
Future Meetings
Recently Elected Members of IFT
Food Industry Topics

Masters and Doctors in Food Technology—1954

(First Installment)

Response to the 1953 listings of advanced degrees attained in the field of food technology was most favorable. Inquiries regarding the subject matter of the theses, and dissertations presented, requests for information on those awarded degrees, and an application for permission to use the lists in a statistical record of investigative trends in food research were among the evidences that the listings are a useful feature. Last year's list indicated that graduate students across America are at work on the chemistry, microbiology, physics, histology, and technology of virtually every commodity on the subsistence market. The listings for 1954 show a similar range. Conventional problems of major importance—for example, heat penetration studies—were investigated, and problems just emerging from the shadows of the future were tackled—for example, the use of plastic containers for heat-processed foods. Topics appear to have been inspired by various factors—new or experimental modes of processing, problems specific to a regional product, problems pertinent to improving or controlling the quality of a product, and so on. The diet of microorganisms continues to be of concern and a considerable amount of detective work is being expended on rancidity—a well-known character in the underworld of food spoilage.

Not all of the advanced degrees listed are being given in June. Those to be awarded (or which have been awarded) at other times are so noted. The lists are alphabetized according to institutions and, within institutions, according to the names of the graduates.

UNIVERSITY OF CALIFORNIA AT BERKELEY

Name	*Degree*	*Thesis or Dissertation*
Chichester, Clinton O.	Ph.D.	On the Maillard Reaction
Wong, Patricia	M.S.	Carotenoid Synthesis by the Mold *Phycomyces*

UNIVERSITY OF CALIFORNIA AT DAVIS

Bettelheim, Frederick A.	M.S.	A Study of Factors Associated with Potato Texture
Delgouzos, John G.	M.S.	Studies on the Acidic Constituents of Brines from "Zapatera" Spoiled Olives
Emerson, Merle	M.S.	Physical and Chemical Changes Occurring in Beef During Dehydration and Subsequent Storage
Demain, Arnold L.	Ph.D.	Studies of Yeast Polygalacturonase
Maier, Vincent P.	M.S.	The Effect of Sub-zero Temperatures on Enzyme Catalyzed Reactions
Recca, Jack A.	M.S.	The Characteristics of Yeasts Occurring in Citrus Products

CORNELL UNIVERSITY, SCHOOL OF NUTRITION

Name	*Degree*	*Thesis or Dissertation*
Munford, Robert Arthur	M.S.	Lethal Effects of Various Gases on Trichina Larvae Encysted in Muscle Tissue
Scheiner, Donald M.	M.S.	The Effect of Organic Compounds on the Growth Rate of Chlorella

THE UNIVERSITY OF GEORGIA

Cecil, Samuel R.	M.S.	Effect of Antioxidants, Smoking, and Storage Temperature on the Development of Rancidity in Country-style Bacon
Lovvorn, Charles Cyril (August '54)	M.S.	Inoculated-pack and Heat-penetration Studies on Canned Pimiento
Mercado (Mrs.) Carmen (August '53)	M.S.	Manual to be Used in the Setting-up and in Operating School Community Canneries in the Philippine Islands
Mills, W. Carlos (August '54)	M.S.	Influence of Relative Humidity, Temperature, and Surface-active Agents on the Curing Rate of Pork Products
Petros, Larbee Wm.	M.S.	Effect of Nutrilites, Starters, and Carbon Dioxide on the Fermentation of Pickles

ILLINOIS INSTITUTE OF TECHNOLOGY

Dienst, Carl Sedwick	M.S.	Application of Mixing Principles to Butter Churning

THE UNIVERSITY OF ILLINOIS

Adams, Harold W.	Ph.D.	Film Deposition of Tomato Juice on Heat Exchange Coils
Garner, Richard G.	Ph.D.	Sweet Corn Dehydration: The Falling-Rate Phase
Hoover, William J.	M.S.	Process Factors Affecting the Quality of Apple Jelly
Hu, Kwoh H.	Ph.D.	Investigation of the Use of Plastic Containers for Heat Processed Foods
Litchfield, John H.	M.S.	A Study of the Stuart Method for the Evaluation of Germicides
Pan, Huo Ping	Ph.D.	Some Carbohydrate Derivatives of Higher Fatty Acids
Potter, George C.	Ph.D.	The Structural Similarity and Biological Activity of Alfalfa Saponins and Soyasapogenols from Soybeans
Schmitt, Norman C.	M.S.	The Bitter Principle in Canned Navy Beans

THE UNIVERSITY OF MARYLAND

Bibi, Zuhair M.	M.S.	Methods of Determining the Suitability of Peach Varieties for Canning and Freezing
Kornetsky, Aaron A.	M.S.	Commercial Application of Quality Control to the Marketing of Sweet Corn for Processing and the Fresh Market
Gigard, Earl D.	Ph.D.	Factors Affecting the Quality of Canned Sweet Potatoes

UNIVERSITY OF MASSACHUSETTS

Cryan, Martin S.	M.S.	Investigations on Low Baumé Pickles
Francis, Frederick J.	Ph.D.	Biosynthesis of the Carotenoid Pigments in Tomatoes
Hadayah, Habib W.	M.S.	Microbiological Studies on Dates
Kopilovich, Shai	M.S.	Utilization of Citrus Peels, with Particular Reference to Alcohol
Kotula, Anthony W.	M.S.	Effect of Environmental Factors on Cranberry Quality
Larkin, Edward P.	Ph.D.	*Enterococci* in Frozen Foods

(Continued on page 6)

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INSIDE SCIENCE

The Vital Story of VITAMIN C

by Science Writer

What does vitamin C do for human beings?

Medical research shows that it is essential in maintaining healthy bony tissue and for the formation of collagen which is the main supportive protein of skin, tendon, bone, cartilage and connective tissue. It is needed for vascular function and tissue respiration and in promoting the healing of wounds. In lactating women it has great importance in providing the infant with a sufficient amount of ascorbic acid to prevent scurvy, a disease to which very young babies are susceptible.

Much evidence is available in medical reports to show that a lack of this vital nutritive element can result in impaired health. And in those cases of frank scurvy which still occur, ascorbic acid is the specific medication.

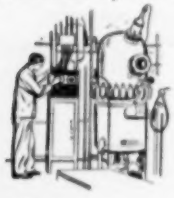
History. The history of vitamin C is fascinating. Scurvy, known for centuries, was once the most prevalent disease in Europe. It afflicted the Crusaders, decimated the crews of voyagers and armies, and plagued the colonists of the New World. In the 18th Century the antiscorbutic value of fresh vegetables and citrus fruits was recognized.

Isolation. It was not until 1918-25 that almost pure ascorbic acid was concentrated from the lemon by Zilva and its important properties and molecular composition established. In 1927 he concluded that this so-called "reducing factor" and the antiscorbutic principle were closely related. In 1928, Szent-Györgyi, who started investigations in 1921, isolated a strong reducing compound from adrenal glands, oranges, and cabbage and termed it "hexuronic acid."

Chemistry. The "reducing factor," "hexuronic acid," and vitamin C were all identified as the same in 1932 by various groups of workers. This was one year after C. G. King, by methods of organic chemistry and experimental physiology, established the chemical identification of vitamin C, thus fulfilling Budd's prediction of 90 years earlier that the antiscorbutic property of certain foods would ultimately be discovered to be a definite substance.

Synthesis. In 1933 Reichstein and his colleagues in Switzerland successfully synthesized ascorbic acid. Almost simultaneously in England Haworth and associates accomplished the same. The Reichstein synthesis formed the basis for large scale commercial production by the world-famous firm of Hoffmann-La Roche.

Production. Following these discoveries came the establishment of manufacturing operations so that today daily production by the tons is the rule. The figures are really staggering. The amount produced weekly in the U. S. A. averages over 15 tons, equivalent to that contained in over 200 million oranges. It is remarkable that ascorbic acid can be produced synthetically and sold for only about $21. per kilogram. One kilo is sufficient to supply 92 people for one year with the minimum daily requirements set by the U. S. Food and Drug Administration.



Vitamin C made by the Roche process is identical chemically and in biological activity with Nature's own product. Because vitamins can be manufactured at a much lower cost than if they were extracted from natural sources they are widely used in dietary supplements and pharmaceuticals. In fact, "New and Non-official Remedies," a publication of the American Medical Association for use by physicians states: "All pure ascorbic acid used in pharmaceutical products is prepared synthetically."

Ascorbic acid is present in many foods. Nature supplies some with lavish amounts and stints on others. In fact, wide variations* have been found in the vitamin C content in varieties of the same fruit.

Deficiencies. Many surveys have shown widespread vitamin C deficiencies in the population. Physicians may call these subclinical, but they are deficiencies nevertheless.

Because of these situations—natural variation and widespread deficiencies—diet experts believe that it is desirable and in the public interest to standardize the vitamin C content of processed fruit and vegetable juices by the addition of enough pure crystalline ascorbic acid to make them consistently dependable sources of this necessary food element. Some of these juices are: tomato, grape, orange, grapefruit, pineapple and apple.

Requirements. The U. S. Food & Drug Administration has set 30 milligrams as the adult minimum daily requirement of ascorbic acid. This daily intake is just about sufficient to prevent recognizable signs of vitamin C deficiencies although a subclinical or an unrecognized deficiency may exist. In view of this, the National Research Council has established 75 milligrams as the recommended daily male adult allowance and 70 mg. daily for female adults, which levels are supported by many controlled nutrition studies. However, the N. R. C. recommends 90 mg. daily for boys between 13 and 15, 100 mg. daily for boys between 16 and 20, and 150 mg. daily for lactating women.

This article is published in the interests of pharmaceutical manufacturers and food processors who make their good products better with essential, health-giving vitamin C. Reprints are freely available. Vitamin Division, Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada: Hoffmann-La Roche Ltd., 286 St. Paul Street, West; Montreal, Quebec.

*The table shows minimum and maximum levels of ascorbic acid in commercially canned juices. All figures are in milligrams per 100 grams of juice. Data from U. S. Department of Agriculture.

	Min.	*Max.*
Apple juice	0.2	3.6
Grape juice	0.0	4.7
Grapefruit juice	10.0	49.0
Orange juice	9.7	70.0
Pineapple juice	5.4	18.0
Tomato Juice	2.5	32.0

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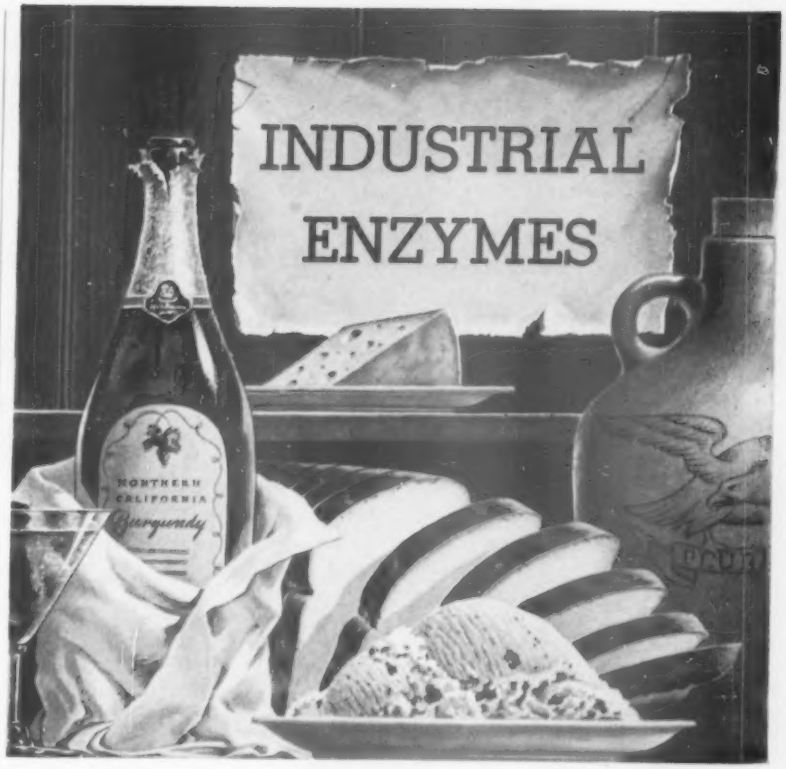

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Master and Doctors in Food Technology—1954

(Continued from page 2)

Lopez-Matas, Hernan M.	M.S.	Epoxides as Dried Fruit Preservatives
Patino, Edgardo	M.S.	Soybean Milk and Cheese
Roseman, Arnold S.	M.S.	Manometric Method for Measuring Micro Air Diffusion in Vacuum Sealed Containers
Sabry, Zakaria I.	M.S.	A Simple Method for Measurement of Color in Strawberry Preserves
Westcott, Donald D.	Ph.D.	Nonenzymatic Browning of Comminuted Green Beans
Zoueil, Mohamed, E. B.	M.S.	Sodium Content of Dried Foods by Flame Photometer

Regional Section News

BRITISH COLUMBIA SECTION

The regular meeting of the Section was held on Tuesday, April 27th in the McGavin Auditorium, Vancouver. The speaker of the evening was Dr. V. J. Oswald, Chemist, Firmenich of Canada, Limited, Toronto, who spoke on "Some Facts and Fancies about Flavour." Dr. Oswald has had many years of experience in the flavor industries, and is presently vice-chairman of the Toronto Section of the Canadian Food Technologists.

A number of guests were introduced by the chairman, Peter Sunderland. From the Food and Drug Division of the Department of Health and Welfare were Mr. Paul Taguy, chief of Inspection Service, Ottawa, Mr. Wagner of Edmonton, Mr. Renton of Calgary, and Mr. Barker of Kamloops. Local guests included Miss Beaveridge of the Coca Cola Company, Miss Kearny and Mr. Savotsky of Kraft Foods Limited, Mr. B. H. Cruttenden, Director of Food Trades, Vancouver Vocational Institute.

Chairman Peter Sunderland introduced Dr. Oswald to the group. In the course of his talk, Dr. Oswald outlined some of the problems of the flavour chemist, whom he defined as one-half scientist and one-half aesthete. Flavours are complex chemical mixtures. Many flavours occur naturally and because of their delicate nature, care must be exercised to preserve them unchanged. Some flavours can be developed, either desirable or undesirable, during processes such as cooking and fermenting. Other flavours must be added in the form of essences or concentrates, which may be natural or synthetic in origin. Dr. Oswald pointed out that flavour can be considered the most important factor in judging food quality. People eat what they like, and flavour plays a very large part in determining what we like! Flavour preferences can be developed, and show up sharply when the flavour preferences of different groups are considered. Flavours that sell well in Ontario are poorly received in certain parts of Quebec and vice-versa.

Flavour manufacturers make considerable use of panels or groups of "expert" tasters to determine the comparative values of similar flavours, to evaluate new formulae, etc. These "expert" panels are not to be confused with consumer acceptance tests. Public acceptance is not usually considered directly by these expert tasters. Their function is to determine minute variations in flavour without having to state which sample they prefer. An interesting example of this procedure was given by Dr. Oswald. Loss of flavours occurs in packaged cake

(Continued on page 8)

Shortenings engineered to order

Modern shortenings are a product of careful design from known principles, like bridges or TV sets. One producer wants a shortening that will produce a very fine crumb structure. Another wants one that will work well in packaged cake mix. Still another wants to make the best possible bread shortening out of a certain fat available to him at a favorable cost. And so the questions come at us.

Among the big differences between the primitive approach to shortening design and the modern approach are the kind and proportions of emulsifying ingredients. Emulsifiers, made themselves from wholesome natural fats and concentrated by molecular distillation,* are our specialty. Many of the principles of their effectiveness are still being worked out in our laboratories, for they are too new for the textbooks. Some of the work is necessarily on a test-tube scale, but more and more the greater part of it is in making up commercially feasible shortenings and trying them under practical conditions.

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REGIONAL SECTION NEWS

(Continued from page 6)

mixes during storage. A number of samples are carefully selected from a batch. These samples are placed in storage at 0° F., where very little loss of flavour will occur. At predetermined intervals, say once a month, a sample is withdrawn and placed in the test temperature, probably 75° F. Regular removals are continued until the desired time has elapsed, say one year. Then all the samples are baked and tasted by the "expert" panel of tasters. Thus, the length of storage time at 75° F. which noticeably affects the flavour can be established. Of course, many other factors can be tested in a similar manner.

After an interesting discussion period, Mr. Granville Boothby thanked Dr. Oswald on behalf of the group.

The results of the mail ballot for next year's slate of officers were announced by Mr. Art Woodland. Those elected were as follows: Chairman: Douglas Dougans of Merck & Company, Vancouver; Vice-chairman: Larry Devlin of Food & Drug Division, Vancouver; Secretary: Bill Pearson of Lucky Lager Brewing Company, New Westminster; Treasurer: Miss Ross of the Vancouver Daily Province, Vancouver; Councillor: Ian Greenwood of B. C. Processors Limited, Kelowna.

Chairman-elect, Mr. Dougans, moved a hearty vote of thanks to Peter Sunderland for the excellent manner in which he has conducted the affairs of the section, and asked the group to assist him in his coming efforts. Those present showed their appreciation with a vigorous round of applause.

MARYLAND SECTION

Thirty members and guests were present at the May meeting of the Maryland Section, which was held in the Terrapin Room of the Dining Hall at the University of Maryland, College Park, Maryland, on Friday, May 14, 1954.

The Section was the guest of the Maryland Student Chapter of the IFT. The meeting started with a conducted tour of the campus followed by a short break for dinner. Following dinner, the members and guests were addressed by Mr. Robinson Lappin, Director of Food Services of the University, who spoke on the subject of "Molding the Eating Habits of the Next Generation."

Mr. Lappin's talk was informative and most entertaining. He paid tribute to the work of food scientists and gave concrete examples of how recent food developments have aided Food Service Men in the preparation and serving of food to large groups of people.

He commented that in his opinion, the college student of today was smarter than his brother or father of yesteryear. In fact, the present-day college student forces the Food Service Man out of the food business and into the public relations business.

In training the eating habits of the student over the four years of college life, he said that the teen-age freshman generally doesn't know what he likes or dislikes. He does know that the institution food is not as good as he receives at home. By the end of the year he still doesn't like the food, but he accepts it.

In the sophomore year he is confused as to his likes and dislikes. In his junior year he begins to like the food and by the time his senior year rolls around, he accepts the food without comment.

The moods of the students, the pressure of extra-curricular activities and the imminence of examinations all have an influence on the eating habits of the students. The college tries to give the student a balanced diet of an average of 3400 to 3500 calories per day.

He spoke briefly on the influence of background music while students are eating, and stated that slow music makes the student eat in a leisurely manner while fast music speeds things up.

All in all his discourse was very entertaining and provoked many questions.

NEW YORK SECTION

The sixth 1954 meeting of the New York Section, Institute of Food Technologists, took place on Wednesday, April 21st at the Brass Rail, with 160 members attending the dinner and meeting.

The main speaker of the evening was Dr. Francis Joseph Weiss, scientific consultant on food and nutrition, whose subject was "Food From the Sea." In these days of underfed populations, it was encouraging to learn that the ocean, which Dr. Weiss described as "our last frontier in nutrition" is a fabulously wealthy and almost untapped source of food materials of high nutritional value. He used the whale as one of the most interesting examples of an enormous food source which is currently almost completely unused. Dr. Weiss described in some detail the methods of production and excellent food values of fish flours which can be provided so economically that it would cost only one to two-hundredths of a cent a day per capita to provide adequate protein food from this source. The use of these fish flours is under serious consideration by WHO.

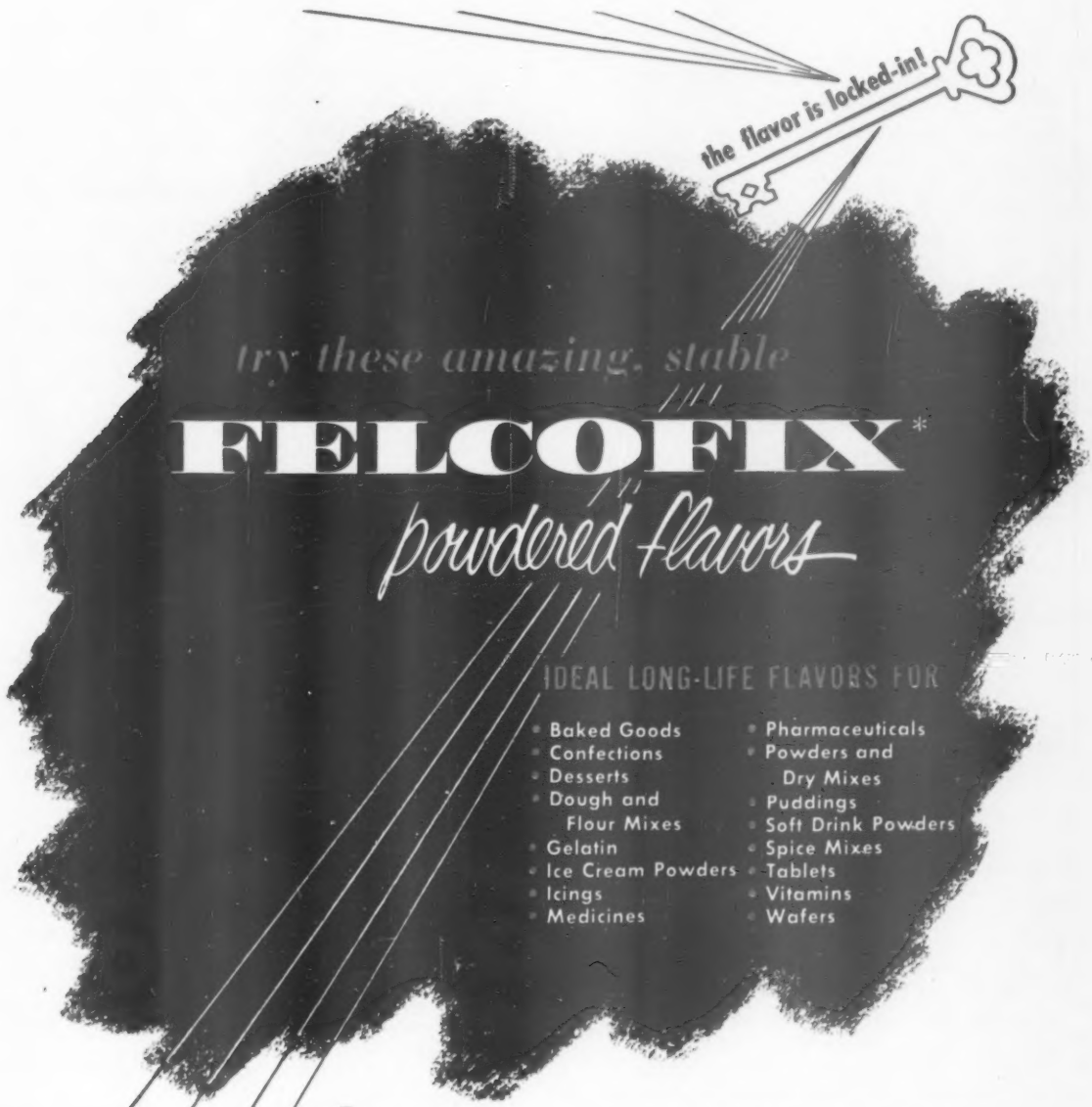
Following Dr. Weiss' fascinating talk, there were two additional shorter talks—one by Earl C. Jertson, President of the Seaplant Chemical Corporation of New Bedford, Mass. and the other by Lloyd B. Rothe of the Technical Department of the Kelco Corporation. These talks dealt with the methods of manufacture and uses of such products as the carrigheens and the alginates. These are rapidly growing industries with their products finding wider and wider uses both in the food industry and in other industries.

PHILADELPHIA SECTION

The Philadelphia Section met April 20 at Drexel Institute. The following officers were elected for 1954-55:

Chairman: Carl D. Pratt
Vice-Chairman: L. W. Mahle
Secretary: E. C. Dryden
Treasurer: R. L. Mullan
Councillor: J. P. Crimmins
Executive Committee: Fred Jacobson, Albert Chaplin

Colonel Lawrence, Business Manager of the Institute, was present and gave a short talk on the affairs of the national organization.

(Continued on page 10)

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REGIONAL SECTION NEWS

(Continued from page 8)

The chief speaker was Dr. Robert R. Williams, pioneer in vitamin research, whose investigations in the field date from the early years of the century, and who first synthesized thiamin in 1936. His talk on "The Enrichment of Foods" covered all phases of the subject, but was chiefly concerned with the enrichment of cereals, with which he has been most closely associated. Two films were shown—one on the enrichment of corn meal and grits in the southern United States, and one on the enrichment of rice in the Orient, including the recent dramatic experiment in Bataan, Philippine Islands, in which beri-beri was practically wiped out in the entire province.

DIXIE SECTION

On Friday, May 21, 1954, the Section met at the Cherokee Hotel, Atlanta, Georgia. Dinner was served at 6:30 p.m. and after dinner Mr. O. C. Yeakley, president of the White Provision Company of Atlanta, spoke on "The Meat Industry Today and Yesterday"—an excellent exposition of the subject. A film on the Production of Meat Products was also shown. An interesting question and answer period followed. Within the next month members will receive a request for confirmation of directory data they have supplied. The directory will be ready by fall.

CHICAGO SECTION

Members of the Chicago Section and their wives experienced another enjoyable meeting on May 13th in Milwaukee, Wisconsin. Host was the Miller Brewing Company.

The program began with a tour through the brewery, followed by refreshments and a hot buffet supper served in an efficient manner in the Miller Inn. A golf session was arranged in the morning for those interested.

Following the supper the 120 members and guests enjoyed the talk given by Dr. Kenneth G. Weckel, Professor of Dairy and Food Industries at the University of Wisconsin. Dr. Weckel reviewed the nature and scope of Wisconsin's food processing facilities, the relation of these to Wisconsin agriculture, and problems within the state's food processing industry, and developmental work in food technology at the University of Wisconsin.

A short business meeting was conducted by program chairman John Jackson. A movie, supplied by the United States Brewers Foundation, entitled "Beer Belongs" completed the meeting.

PERSONNEL

Barbara Hutchings Evers, nationally known home economist and co-author with Donald K. Tressler and C. F. Evers of the book, "Into the Freezer and Out," has joined the staff of the Division of Home Economics of the American Meat Institute Foundation, it is announced by Dr. H. R. Kraybill, the Foundation's Director of Research and Education.

Mr. Lloyd E. Slater, Chicago editor of *Food Engineering*, has been appointed to the post of Promotion Manager and Business Editor of *Control Engineering*, a new McGraw-Hill journal devoted to automation and instrumentation in industry. His headquarters will be in New York City.

Selected Abstracts*

ANALYTICAL METHODS

The determination of hydroxyl, ketone and ester groups in autoxidized fatty esters and related compounds by infrared spectroscopy.

Ahlers, N. H. E., and McTaggart, N. G. *Analyst, 79,* 70-6 (1954).

Methods are devised for the quant. detn. of hydroxyl, ketone and ester groups in autoxidized or copolymerized fatty esters and related compds. They require only small amts. of sample (20 mg.). The accuracy of each detn. is similar to that of the corresponding conventional chem. method.

A modified peroxide test for detection of lipid oxidation in dairy products.

Stine, C. M., Harland, H. A., Coulter, S. T., and Jenness, R. *J. Dairy Sci., 37,* 202-8 (1954).

The use of a nonionic detergent (BDI reagent) for breaking the emulsion was found a satisfactory means of obtaining fat for estn. of peroxide value by the ferric thiocyanate method. The procedure is applicable to milk, cream, and condensed and dried milk products. It appears to be very satisfactory for routine control purposes. Its reproducibility and sensitivity are excellent.

Analysis of sodium pyro- and tripolyphosphate mixtures.

Mabis, A. J., and Quimby, O. T. *Anal. Chem., 25,* 1814-18 (1953).

A quant. method was developed based on x-ray diffraction using MgO as an internal standard. Calibration involves application to mixts. of cryst. $Na_4P_2O_7$, the 2 anhydrous phases of Na tripolyphosphate and the hexahydrate of Na tripolyphosphate. X-ray spectrometers were used to measure intensities of x-ray diffraction peaks. Preferred crystallite orientation was avoided by special methods of sample prepn. The av. deviation of the results is of the order of 3%, based on analysis of mixts. of known compn. Total tripolyphosphate by x-ray diffraction will be identical to the chem. result for a fully crystd. sample, but lower than the chem. result, if some of the tripolyphosphate is amorphous.

Paper chromatographic separation of poly- and meta-phosphates. I. Development of method. II. Quantitative application.

Ebel, J. P. *Bull. soc. chim. France, 20,* 991-1000 (1953); *Anal. Abstr., 1,* No. 283 (1954).

A qual. and reasonably accurate quant. ascending chromatographic procedure is developed for the sepn. of linear polyphosphates (ortho-, pyro-, tri-phosphates and Graham's salt) and cyclic metaphosphates. $(NaPO_3)_3$, $(NaPO_3)_4$ in mixts.

Some notes on the determination of methyl ketones.

Berridge, N. J., Zielinska, M., and Barrett, J. *J. Sci. Food Agr., 4,* 472-7 (1953).

Methyl ketones are known to occur in rancid fats and to contribute to the flavor of cheese. Mixts. in soln. must be sepd. for analysis by chromatography or similar means.

Colorimetric determination of anionic detergents.

Loomeijer, F. J. *Anal. Chim. Acta., 10,* 147-50 (1954).

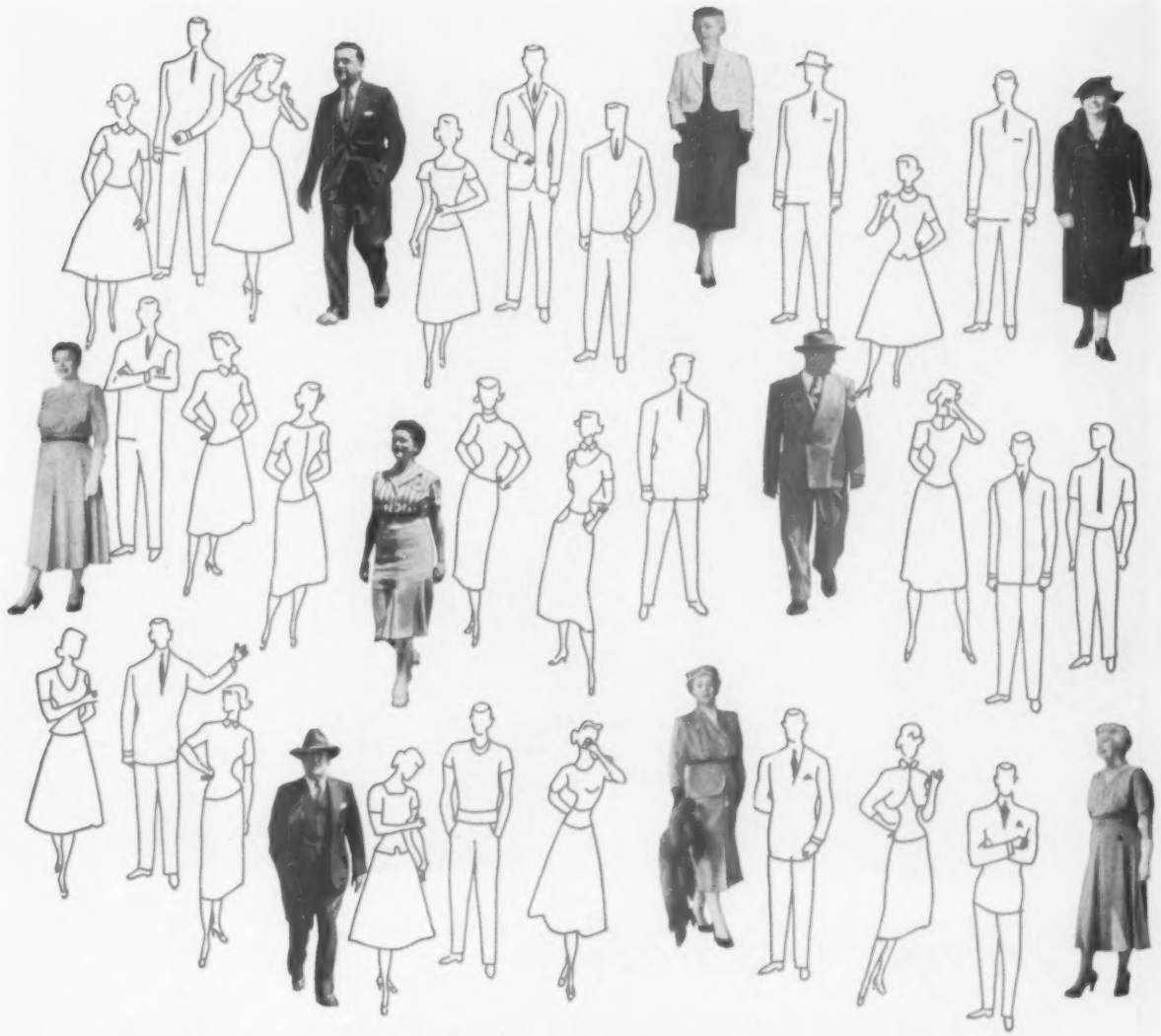
Many types of anionic detergents can be dctd. colorimetrically by the action of the detergent on a protein-bromcresol purple complex. The amt. of free dye liberated from the complex is proportional to the amt. of detergent added between certain limits.

Colorimetric determination of pyrethrins, allethrin, and furethrin.

Cueto, C., and Dale, W. E. *Anal. Chem., 25,* 1367-9 (1953).

* These Selected Abstracts are made available to Food Technology through the cooperation of Associate Editor H. A. Campbell and the General Foods Corporation of New York, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

(Continued on page 14)



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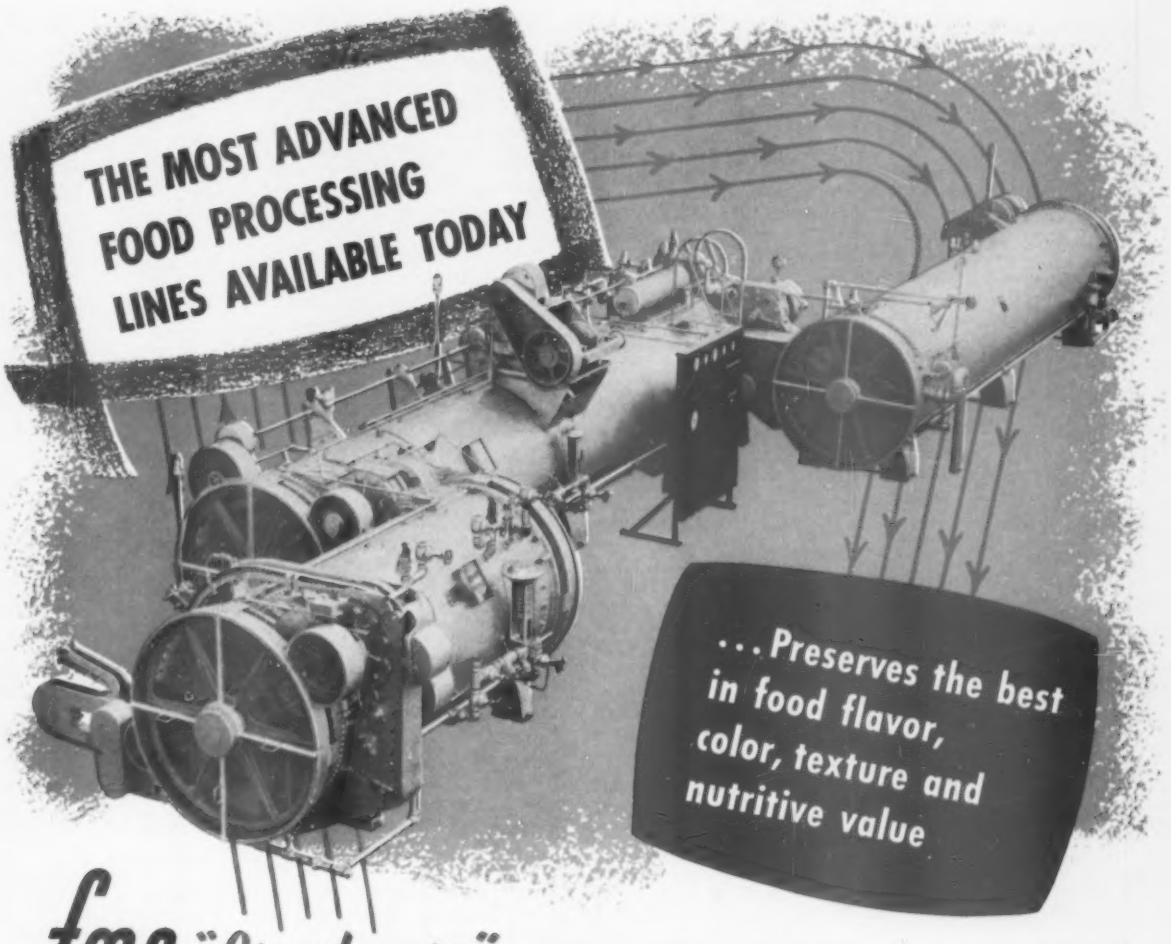
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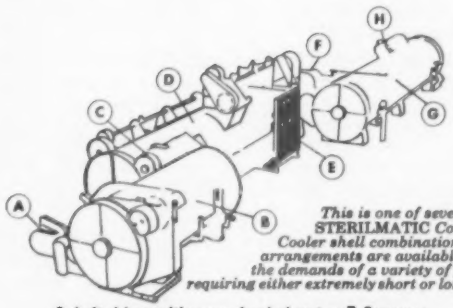

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SELECTED ABSTRACTS

(Continued from page 10)

The use of pyrethrins, allethrin, and possibly furethrin as a coating on paper and cloth bags for the protection of stored food products against insects has created a need for a sensitive, accurate, and rapid method of detection and detn. of these materials. Such a method might also find use in the detn. of residues on food products and in the analysis of concentrates and various formulations. A colorimetric method developed for the estn. of small amts. of pyrethrins, allethrin, and furethrin is sensitive to about 200 γ and has an av. exptl. error of about 4%.

Multiple-color development method for use in paper chromatography.

WOODWARD, C. C., AND RABIDEAU, G. S. *Anal. Chem., 26,* 248 (1954).

A method is here reported by which amino acids, org. acids, and sugars can be detected using, sequentially, 3 color-developing indicators. Further treatment affords differentiation between reducing and nonreducing sugars.

Infra-red spectra of carbohydrates. Part I. Some derivatives of D-glucopyranose.

BARKER, S. A., BOURNE, E. J., STACEY, M., AND WHIFFEN, D. H. *J. Chem. Soc.,* 171-6 (1954).

I. r. spectra offer powerful means for the comparison of supposedly identical samples of carbohydrates. Spectra over the frequency range 730-960 cm.$^{-1}$ enable derivs. of D-glucopyranose to be assigned to either the α- or the β- series, no matter whether they are reducing sugars, Me glucosides, or polysaccharides; thus, α-anomers absorb at 844 ± 8 cm.$^{-1}$, and β-anomers at 891 ± 7 cm.$^{-1}$. In addn., an indication may be obtained of the positions of the glycosidic linkages in a polyglucosan.

The lipase activity of certain cereal products.

TEMPLETON, W. H., AND CARPENTER, B. R. *Analyst, 78, 726-7* (1953).

Lipase activity frequently causes off-flavors in finished baked goods. This method provides a simple test for lipase, based on the amt. of acid formed in olive oil under controlled conditions by a defatted sample of flour or other cereal product.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

Effect of silicone coatings on denaturation of egg albumin.

KUKIN, I., AND ROCHOW, E. G. *J. Polymer Sci., 13,* 301-16 (1954).

It was found that little or no denaturation of the albumin occurred when the soln. of it was shaken for extended periods in either clean glass or silicone-lined bottles in the absence of air. In the presence of a gas interface denaturation was fairly rapid, but proceeded at a somewhat lower rate in silicone-treated bottles than in clean bottles. A relatively thick oily film of methyl silicone deposited by another method greatly increased the rate of denaturation, an effect due to a large degree to the increased oil-water interface created by the dispersion of silicone oil droplets in the soln. during shaking. A theoretical interpretation of these observations in terms of possible mechanisms is given.

The synthesis of lactose from glucose in the mammary gland.

REISS, O. K., AND BARRY, J. M. *Biochem. J., 55,* 783-5 (1953).

Glucose labelled uniformly with C^{14} was injected intravenously into a lactating goat and the specific activities of blood glucose, of lactose, and of the glucose and galactose residues of lactose were measured in blood and milk samples taken up to 12 hr. after the injection. The results show that blood glucose was the principal source of both the glucose and galactose residues of the milk lactose.

Effect of culture medium on lipase and esterase activities of Aspergillus niger.

RAMAKRISHNAN, C. V. *Chemistry & Industry,* 250-1 (1954).

An attempt is made to obtain an active mutant strain of *A. niger* with enhanced lipolytic activity by growing *A. niger* strain several times in a medium contg. old mold filtrate.

Some general characteristics of enzyme foam fractionation.

LONDON, M., COHEN, M., AND HUDSON, P. B. *Biochim. Biophys. Acta., 13,* 111-20 (1954).

Variations of foam purification conditions for urease and catalase, separately, were studied. It was demonstrated that impure urease and catalase mixts. could be sepd. considerably from one another, and each could be sepd. from most other contaminating proteins. The effect of several variables on the foaming method of sepg. enzymes from protein was investigated, and some general rules were presented for the fractionation.

Irradiation effects: effect of certain vitamins and antioxidants on irradiation-induced autoxidation of methyl linoleate.

POLISTER, B. H., AND MEAD, J. F. *J. Agr. Food Chem., 2,* 199-200 (1954).

The effect of several antioxidants in preventing autoxidation of Me linoleate induced by irradiation was studied. Vitamin A, ascorbic acid, glutathione, and cysteine were largely destroyed; calciferol was not affected, although it showed a low order of antioxidant activity; and catalase had no effect. Tocopherol and lonol were effective at concns. so low that the extent of their destruction was not measured.

Enzyme inhibition studies in relation to drug action. II. Action of certain antibiotics on papain.

MOHAN RAO, V. K., KRISHNA MURTI, C. R., AND SHRIVASTAVA, D. L. *J. Sci. Ind. Research* (India), *11B, 299-302* (1952); *Biol. Abstr., 28,* 345, No. 3510 (1954).

The effects of penicillin, dihydrostreptomycin, Chloromycetin and Aureomycin on the milk clotting and casein hydrolyzing activities of papain, were studied. The antibiotics reversibly inhibit the milk clotting activity and accelerate the casein hydrolyzing activity.

Nonpharmaceutical uses of antibiotics.

J. Agr. Food Chem., 1, 1096-102 (1953).

Use for animal feed supplements, food preservation, fermentation control, plant growth and plant disease control are reviewed.

NUTRITION

The multiple etiology of obesity: production of two types of obesity in littermate mice.

MAYER, J., AND ZIGHERA, C. Y. *Science, 119,* 96-7 (1954).

Goldthioglucose obesity is produced by injection of the LD_{50} dose. About 30% of the animals that survive injection become obese. It is readily shown that goldthioglucose obese animals (I) do not show hyperglycemia as do the hereditary obese animals (II). I do not exhibit any increase in blood glucose when treated with growth hormone as do II.

Amino acid composition of human milk.

SOUPART, P., MOORE, S., AND BIGWOOD, E. J. *J. Biol. Chem., 206,* 699-703 (1954).

The amino acid compn. of human milk represents a standard of reference in infant nutrition. Chromatographic analyses were carried out to provide as complete a tabulation as possible of the amino acids which enter the diet from this source.

Oat products. Their nutritive and dietary value.

Milling (Liverpool), *120,* 643-4 (1953); *Biol. Abstr., 28,* 58, No. 564 (1954).

Discusses factors which may have a bearing on declining consumption of oat products, and reviews the value of oats as a component of dietary. Compared with wheat, barley, maize, rye, and rice, oats have the highest fat content, highest thiamine content, and second highest mineral matter content. But, oats are high in fiber and low in niacin. One important reason given for the decline in oat products consumption is replacement by more easily prepd. cereal breakfast foods. This might be countered by producing from oats an attractive food of the flaked or puffed type.

The metabolism of fats.

GREEN, D. E. *Sci. American, 190,* 32-6, January, 1954.

The author reviews the key discoveries in the search for the steps by which the body oxidizes fatty acids. The recent work on the role of enzyme A in the modern scheme of fatty acid oxidation is reported.

(Continued on page 16)

Patisserie, Pastry or Patty–Spices Make the Difference

No less than the Royal Baker of three hundred years ago, the master baker today must cater to tastes that are most discriminating. Perhaps even more so, for the relatively uneducated palates of centuries ago, even among royalty, never tasted the likes of the most common bakery offerings of today.

In those days, too, the baker leaned heavily on spices, their rarity and expense making them truly treasures of the rich. Purity and quality were minor to the fact of their availability. But even then, the baker knew that his product depended on its ingredients, and spices were the prize in trade route wars, the ransom of captives, the bribery for political and economic advantage.

Somewhat less colorful in character today, spices are even more important to the huge industry which has developed out of the kitchen baking oven. KNICKERBOCKER is proud of the part it has played in such development.

For well over a century–112 years–KNICKERBOCKER has played a central role in gathering and making available on an economical basis the finest of spices from all parts of the world.

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SELECTED ABSTRACTS

(Continued from page 14)

A low-cost, high protein, low calorie food.

SURE, B. *J. Clin. Nutrition, 1,* 534-8 (1953).

A new low-cost, high protein, low calorie food is described. It contains defatted soya flour, dry nonfat milk solids, whole wheat, and vegetable shortening. It is supplemented with minerals and vitamins. The protein content is 17% and its caloric value is 750 cals. per lb. or about half that of hamburger meat. It has had excellent acceptance as a meat extender and meat substitute in over 10,000 test meals among students of all ages and in various institutions.

Absence of a time factor in the relationship between level of energy intake and protein metabolism.

MUNRO, H. N., AND WIKRAMANAYAKE, T. W. *J. Nutrition, 52,* 99-114 (1954).

Expts. are described in which addl. carbohydrate (glucose) given to dogs already receiving adequate diets, caused reduction in urinary N. Similar expts. on human subjects and on rats also demonstrated a fall in N output. N retentions of similar magnitude were also observed when an isodynamic amt. of fat was superimposed on the basal diet. From a consideration of these and previously published expts, it was concluded: (1) Protein utilization is favorably influenced by the presence of some carbohydrate in the protein contg. meals. Close proximity in the time of eating carbohydrate and protein is necessary for this interaction to take place, and fat cannot be substituted for carbohydrate. (2) Although carbohydrate and fat act interchangeably as energy sources in sparing protein, they do not need to be taken along with dietary protein.

The comparative nutritive value of corn of high and low protein content for growth in the rat and chick.

SAUBERLICH, H. E., CHANG, W.-Y., AND SALMON, W. D. *J. Nutrition, 51,* 623-35 (1953).

A series of corn samples, ranging in protein content from 6.8-13.6%, was employed in feeding expts. with rats and chicks. The high-protein samples were superior to the low-protein samples when fed on the basis of equal proportions of corn grain in the diet. The low-protein corn was found to be deficient in at least the following amino acids: lysine, tryptophan, isoleucine, threonine and valine. In contrast, the high-protein corn was deficient in only lysine and tryptophan, although not as severely deficient as the low-protein corn. When the corn was fed on the basis of equal protein content in the diet, the high-protein corn was somewhat inferior to the low-protein corn, reflecting a greater proportion of zein in the protein. Studies on the supplementation of corn diets with various natural protein materials indicated that soybean meal is the most satisfactory of those tested. The protein supplements were most effective when added to the high-protein corn diets.

Influence of various carbohydrates on the utilization of low protein rations by the white rat. II. Comparison of several proteins and carbohydrates. Growth and liver fat.

HARPER, A. E., MONSON, W. J., ARATA, D. A., BENTON, D. A. AND ELVEHJEM, C. A. *J. Nutrition, 51,* 523-37 (1953).

Dextrin supported better growth of rats than sucrose, whether the protein in the diet was supplied as casein, egg albumin or wheat gluten or whether a mixt. of amino acids simulating casein was used. With low-casein diets cerelose supported growth which was intermediate, while with fructose growth was slightly below that obtained with sucrose. The liver fat deposition of rats fed low-casein diets or amino acid diets of similar compn. was reduced when the sucrose in the diet was replaced by dextrin. This effect of dextrin on liver fat deposition could not be demonstrated when other proteins were fed. The implications of the results were discussed and it was suggested that each of these observations can be explained as a result of improved utilization of dietary protein when the sucrose in low-protein diets is replaced by dextrin.

Comparative studies on the enzymatic decomposition of various types of starch.

LOEB, M. *Ann. Paedjat., 181,* 1-16 (1953); *Biol. Abstr., 28,* 55, No. 529 (1954).

Starch from potatoes, maize, rice, barley, rye and oats was exposed *in vitro* to pancreatic amylase. Decompn. was observed using Bertrand's reduction method and I_2 color reaction. The kinetics of the reaction are discussed. Using identical enzyme and substrate concns., no difference was found in the speed and maximal degree of decompn. of the above starches except potato starch which was hydrolyzed faster and to a lower stage. Decompn. was similar in native and sol. starches. The time required to cool the various types of starch paste had no relation to their digestibility.

The correlation between feed consumption and fecal flora in chicks.

SLINGER, S. J., HAUSER, M. M., AND PEPPER, W. F. *J. Nutrition, 52,* 75-88 (1954).

The results suggest that penicillin stimulates chick growth by causing an increase in feed consumption early in the life of the bird. The real increase in feed consumption, the increase per unit of body wt., caused by penicillin appeared to be assocd. with an increase in fecal coliforms or a decrease in fecal counts of lactobacilli, anaerobes, aerobes and enterococci groups of microorganisms, or both.

Further evidence as to the possible mechanism involved in the growth-promoting responses obtained from antibiotics.

JACOBS, R. L., ELAM, J. F., ANDERSON, G. W., GEE, L. L., FOWLER, J., AND COUCH, J. R. *J. Nutrition, 51,* 507-13 (1953).

Data from 2 separate expts. show that the oral administration of penicillin, erythromycin, aureomycin, bacitracin, chloromycetin, furazolidone or *p*-chlorophenylarsonic acid failed to stimulate the growth of chicks reared in clean quarters. These supplements likewise failed to decrease the total no. of clostridia present per g. of feces. This is further evidence that antibiotics stimulate growth by reducing the total no. of clostridia in the intestinal tract of the chick and are ineffective in stimulating growth in a clean environment where the clostridia population is low.

PHARMACOLOGY AND TOXICOLOGY

The metabolism and tolerance of adipic acid.

LANG, K., AND BARTSCH, A. R. *Biochem. Z., 323,* 462-8 (1953); *Biol. Abstr., 28,* 103, No. 1011 (1954).

Four hundred mg. of adipic acid (A) fed daily for 33 wks. produced no detectable injury. An 11% protein diet caused the 400 mg. dose to inhibit growth. An 800 mg. daily dose produced diarrhea, changes of the hair and behavior of the animals and inhibition of growth. Feeding greater amts. of A produced injury principally to the interstitial mucosa.

Toxic chemicals in agriculture residues in foods.

Food Trade Rev., 24, 1, March, 1954.

A review of the second Report of the Working party on precautionary measures against toxic chemicals in agriculture. There is no evidence of human illness arising from toxic substances in current use.

Toxicity of silica. II. Characteristics of protein films absorbed by quartz.

SCHEEL, L. D., SMITH, B., VAN RIPER, J., AND FLEISHER, E. *Arch. Ind. Hyg. and Occupational Med., 9,* 29-36 (1954).

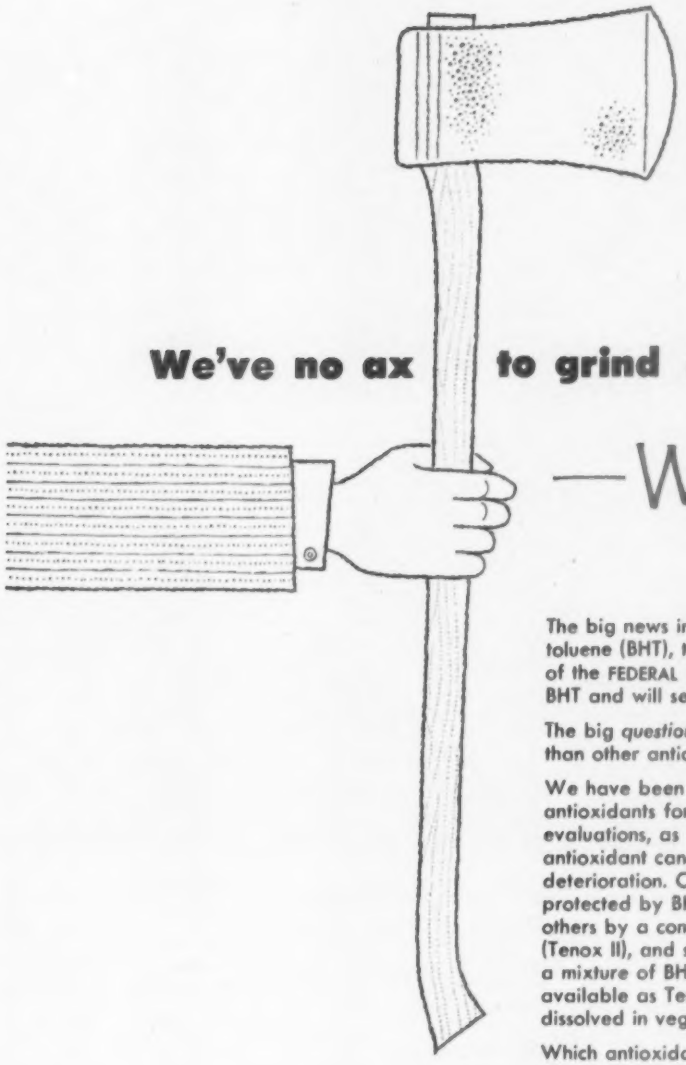
The amt. of protein adsorbed is shown to be a function of the pH and of the concn. of the protein soln. The lack of specificity of the protein film on the quartz surface is shown both by the combination of the adsorbed film with specific antibodies and by the ability of the film to produce heterogeneous antibodies when injected into the rabbit. It is possible that the toxic action of the quartz particle may be the result of a foreign protein reaction in the tissues.

Antithyroid action of antibiotics.

CALESNICK, B., HARRIS, W. D., AND JONES, R. S. *Science, 119,* 128-9 (1954).

Evidence was found, in studies with rats, that aureomycin and K penicillin G have a goitrogenic action which stimulates the thiouracils. Although limited data was presented, there is evidence that these 2 antibiotics inhibit thyroid activity as measured by the uptake of I^{131} and the wt. of this gland.

(Continued on page 18)



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The big news in food-grade antioxidants is butylated hydroxytoluene (BHT), the use of which is defined in the May 20th issue of the FEDERAL REGISTER. Eastman is currently manufacturing BHT and will sell it as one of its line of Tenox antioxidants.

The big *question* is, "Where can it be used more effectively than other antioxidants?"

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SELECTED ABSTRACTS

(Continued from page 16)

Behavior of the nitrate ion in the dog.

GREENE, I., AND HIATT, E. P. *Am. J. Physiol., 176,* 463-7 (1954).

The absorption, distribution, fate, toxicity and effect on electrolytic balance of nitrate salts were studied in 30 expts. on 13 dogs.

Phenol coefficients and the Ferguson principle.

ALLAWALA, A., AND RIEGELMAN, S. *J. Am. Pharm. Assoc., Sci. Ed., 43,* 93-7 (1954).

The correlation between the thermodynamic activity and the antibacterial action was substantiated through the application of the Ferguson principle to a series of phenols varying in their phenol coeffs. from 1-675. By use of a cell suspension method and carefully prepd. satd. solns., it was shown that the solns. of these phenols must be 18-20% satd. in order to kill a standardized suspension of *M. pyogenes* var. *aureus* in 10 mins. but not in 5 mins.

FOOD AND FOOD TECHNOLOGY

BAKING

Chemistry of leavening. Part II.

VAN WAZER, J. R., AND ARVAN, P. G. *Northwestern Miller, 251,* 3a-5a', March 9, 1954.

CO_2 carriers and leavening acids are discussed in detail.

CEREALS AND GRAINS

Wheat products.

MOHAMMAD, A., MECHAM, D. K., AND OLCOTT, H. S. *J. Agr. Food Chem., 2,* 136-7 (1954).

A deriv. of wheat gluten was prepd. by treatment with H_3PO_4 and urea at 140°, an adaptation of a procedure used for phosphorylation of cellulose. The phosphorylated product was capable of adsorbing about 200 times its wt. of H_2O to form a firm gel. This method has several advantages over those previously described for making the gel-forming deriv. by sulfation or phosphorylation.

GELATIN AND GUMS

The color and clarity of gelatin and glue solutions.

SAUNDERS, P. R., AND WARD, A. G. *J. Sci. Food Agri., 4,* 523-7 (1953).

A method is described for measuring the separate properties, color and clarity of gelatin and glue solns. The optical ds. of gelatin or glue solns., before and after filtration by means of a bacterial filter, are measured either as a function of wavelength, with a spectrophotometer, or in terms of the light transmitted by standard color filters, with a photoelec. absorptiometer. The limitations of the method and its usefulness in routine control are discussed.

A half century of progress in collagen chemistry.

HIGHBERGER, J. H. *J. Am. Leather Chemists Assoc., 48,* 704-19 (1953).

A brief summary of the progress in collagen chemistry is presented. The reconstitution of collagen fibrils into forms called "fibrous long-spacing" and "regment long-spacing" is described. At present it is not known if these forms with length of 2000 A are in fact the collagen mol. 48 references.

A structure for collagen.

CRICK, F. H. C. *Chem. Phys., 22,* 34-78 (1954).

A model is proposed for part of the collagen mol. on the basis of electron microscopy studies and it is found to be in qual. agreement with the x-ray data.

Viscosity and molecular weight of degraded carrageenin.

MASSON, C. R., AND CAINES, G. W. *Can. J. Chem., 32,* 51-8 (1954).

Viscosities and no. av. mol. wts. of various carrageenin prepns., including thermally and photochemically degraded samples, were measured. Aq. solns. of carrageenin of low mol. wt. are shown to exhibit viscosity characteristics which are entirely similar to those of other natural and synthetic polyelectrolytes. Solns. of carrageenin of high mol. wt. exhibit plastic flow. The relationship between viscosity and mol. wt. for the degraded polymer indicates that the mol. configuration in soln. is that of a fairly stiff rod, even in the presence of salts.

MILK AND MILK PRODUCTS

Studies on improving the ease of reconstitution of skim milk powder.

GIBSON, D. L., AND RAITHBY, J. W. *Can. J. Technol., 32,* 60-9 (1954).

In an effort to improve the ease of reconstitution of skim milk powder, methods of reconstitution and technics of manuf. were studied. It was found that reconstitution at a temp. of approx. 50° C. gave the highest wettable value. Reconstituting above 60° C. markedly reduced reconstitutability. Powder particles with a diam. of less than 15 μ were more difficult to reconstitute than those having a diam. of 15-25 μ. The addn. of up to 25% by wt. of sugars or sugar derivs. produced no appreciable effect on wettability unless they were added after drying. Surface active agents of the Tween variety at concns. as low as 0.1% by wt. of the skim milk powder improved wettability.

The role of lactones in flavor deterioration of milk fat.

PATTON, S., KEENEY, P. G., AND HERALD, C. T. *Science, 119,* 218-19 (1954).

At an early stage in the storage deterioration of anhydrous milk fat a coconut-like flavor defect is evident. Evidence indicates that the flavor and odor properties of δ decalactone appear to be identical with the coconut-like off-flavor of milk fat. A logical origin of this lactone is Δ^6 decenoic acid, a component of milk fat glycerides.

PRESERVATION

Chemical preservatives.

HANSEN, A. *Konserves, 11,* 25-32 (1953); *Food Sci. Abstr., 26,* 109, No. 503 (1954).

A preservative is effective whether it attacks (1) the genetic mechanism, (2) the membrane of the cell walls, or (3) the cytoplasm of the spoilage organism. As a result of recent studies on the effects of preservatives on the enzymes of microorganisms, the choice of preservatives for particular cases were reconsidered. Also discussed are: the sensitivity of certain preservatives to pH; the distribution of preservatives between the environment and the lipid-contg. cytoplasm of the microorganism; the ability of preservatives to alter the O_2 tension of the medium; and other phys. factors. Some preservatives in common use, as well as recent discoveries such as monobromoacetic esters, are discussed.

SUGARS

Sugar solubility.

SEGUR, J. B., AND MINER, C. S. *J. Agr. Food Chem., 2,* 132-5 (1954).

The soly. of sucrose-dextrose mixts. and of invert sugar in aq. glycerol at 25° and 35° C.

Books

BIOCHEMISTRY AND PHYSIOLOGY OF NUTRITION. Vols. I and II. Edited by G. H. Bourne and G. W. Kidder. 471 and 582 pages. Author and subject indices. Academic Press, Inc., New York, 1953. Vol. I, $13.00; Vol. II, $15.00.

The editors state that this treatise " . . . is directed to all workers dealing with problems of metabolism as well as to the nutritionist . . . " and this direction is evident. The book is not to be considered an elementary text and requires of the reader a background of training in both biochemistry and physiology.

The format and type selected make for good readability and references are conveniently placed as footnotes. Although an author index of reference publications and a subject index are supplied with each volume

(Continued on page 24 following technical papers)

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Air Cell Mold in Oiled Eggs[a]

HELEN J. BROWN AND N. E. GIBBONS
Division of Applied Biology, National Research Laboratories, Ottawa, Canada

(Manuscript received February 3, 1954)

Mold growth is found occasionally in the air cells of oiled eggs, but is rarely seen in unoiled eggs. Oiling seals the shell allowing the accumulation of carbon dioxide which lowers the pH of the albumen and stimulates germination of mold spores and early development of hyphae. Growth is usually self-limiting owing to depletion of oxygen.

Mold growth in the air cell is observed occasionally in stored oiled eggs, but is almost unknown in unoiled eggs held for long periods under similar conditions. In 1937 Moran *(6)* mentioned mold growth in the air cell of a sealed egg, but the condition did not receive widespread recognition until the postwar period when large numbers of oiled eggs shipped to England from Canada were rejected because of air cell mold. Although losses from this cause were subsequently reduced by improved handling techniques, an investigation of the factors contributing to the development of air cell mold appeared to be of considerable interest. The first part of the paper contains observations on the appearance of the molds and on the relation of air cell mold to external factors. The second part describes experiments which show that mold growth in the air cell may be stimulated by conditions produced within the egg as a result of oiling the shell.

General Observations

Members of the *Asymetrica* series of the genus *Penicillium* were most frequently encountered in eggs with air cell mold; of these, *P. expansum* was the most usual contaminant. *Sporotrichum carnis, Cladosporium herbarum, Scopulariopsis sp.* and *Wardomyces anomala* were also found several times.

The amount of mold growth in the air cell varied considerably. Usually small narrow colonies ringing part or all of the air cell were found, but occasionally the air cell was completely filled with mold growth (Figure 1). Early growth was often difficult to detect by candling, especially when white or grey molds were present or when sporulation had not taken place. The mycelium was usually stunted in appearance and spore formation, when it occurred, was not normal. When small mold colonies in the air cell were seen with the candling lamp, the eggs could generally be incubated at room temperature for several weeks without increase in colony size. When air was admitted to the air cell the colonies resumed growth, sporulated, and soon attained a normal appearance. This seemed to indicate that conditions in the air cell, while allowing or even favoring germination of contaminating spores, were not favorable for continued growth.

Chance contamination apparently accounts for the presence of mold spores in the air cell, but little is known of the mechanism by which they penetrate the shell and membranes. Despite the reduction in air cell mold attributed to improved commercial handling methods, laboratory experiments designed to favor penetration of mold spores through the shell failed to produce air cell mold in oiled eggs. Eggs sprayed with mold spores and allowed to develop condensate on the shells before oiling rarely developed air cell mold. Attempts to draw spores into the air cell by dipping the eggs in oil cooler than the egg temperature were also unsuccessful in increasing the incidence of air cell mold.

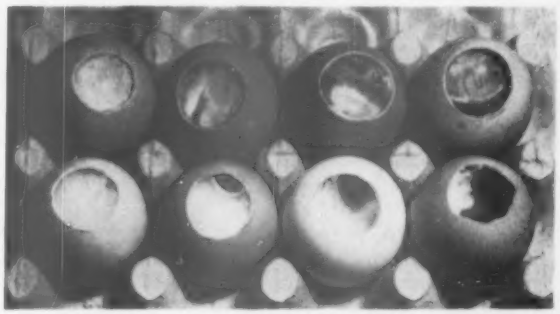

Figure 1. Typical naturally occurring mold growth in the air cells of oiled eggs.

An examination of commercial egg storage plants in conjunction with the Canada Department of Agriculture showed that the percentage of air cell mold in different lots of stored oiled eggs varied considerably, although the average loss was less than one percent.[b] Annual variation in losses in the same cold stores was so great that the occurrence of air cell mold could not be related to local conditions. Attempts to correlate the prevalence of air cell mold with storage temperature have also been unsuccessful. Temperatures were determined in several cold stores over the entire season by means of thermocouples and recording thermometers distributed in egg cases throughout the rooms. The only finding of interest was that actual temperatures in the egg cases were 1 to 6° F. (0.56-3.3° C.) higher than those indicated by thermometers used by the warehouse personnel. However, increasing the laboratory storage temperature from 30° F. (—1.1° C.) to 40° F. (4.4° C.) failed to produce air cell mold in oiled eggs held at 90% R. H.

The Effect of Gas Concentration Within the Egg on the Development of Air Cell Mold

Since external conditions seem to have little effect on the occurrence of air cell mold in oiled eggs, stimulation of mold growth appears to be related to some internal factor. Moran *(6)* suggested that increased humidity of the air cell might be responsible for growth of contaminating mold spores and proposed leaving the air cell

[a] Issued as Paper No. 300 of the Canadian Committee on Food Preservation and as N. R. C. No. 3310.

[b] Unpublished data.

unoiled as a means of control. However, Rose and Gibbons *(7)* showed that the relative humidity in the air cell of an unoiled egg was over 99% and concluded that oiling could not promote mold growth by increasing the humidity of the air cell.

Oiling the egg restricts diffusion of gases through the shell and allows carbon dioxide to accumulate within the air cell during storage *(2, 7, 9)*. The stimulating effect of low carbon dioxide concentrations on mold growth *(4, 10)* suggests a possible explanation for the development of air cell mold in oiled eggs. Because air cell mold is accompanied by a marked decrease in the oxygen content of the air cell gas *(7)* in addition to an increase in the carbon dioxide content, the stunted appearance of mold growth in the air cell may be related to the inhibitory effect of low oxygen concentrations *(3, 5)*.

The present paper records some observations on the effect of carbon dioxide, oxygen, and pH on molds grown under conditions similar to those found in eggs, and attempts to explain the occurrence of air cell mold on the basis of these findings.

MATERIALS AND METHODS

Penicillium expansum, *Sporotrichum carnis*, and *Cladosporium herbarum* were selected as representative species from eggs with air cell mold. Spore suspensions were prepared by shaking the growth from malt agar slants with sterile sand and distilled water.

To determine the effect of carbon dioxide and oxygen on mold growth *in situ*, the shells and outer membranes surrounding the air cells of day-old eggs were removed (as in Figure 1) and the exposed air cell membranes inoculated with a loopful of spore suspension. The eggs were incubated in atmospheres maintained at 80 and 100% R. H. and containing 0, 5.0 and 10.0% carbon dioxide and <1.0, 5.0, 10.0 and 20.0% oxygen. The surface of albumen and pieces of air cell membrane floating on egg albumen were similarly inoculated, and the effect of 0, 2.5, 5.0, 7.5 and 10.0% carbon dioxide on mold growth at 100% R. H. was observed. Control colonies were grown on malt agar.

Several difficulties were experienced with the use of these materials as culture media. Even slight drying of the air cell membrane produced considerable inhibition of growth but when a relative humidity high enough to prevent drying was employed, the test colonies were often obscured by contaminating mold growth from the shell. Quantitative data could not be obtained because the type of mold growth found on both membranes and albumen could not be accurately measured. Therefore, it was necessary to develop an artificial medium which reacted with carbon dioxide in essentially the same manner as egg albumen. Most of the data reported in this paper were obtained from mold colonies grown on a medium containing 1.0% Difco neopeptone, 1.0% dextrose, 1.5% agar and 0.53% (0.05 M) sodium carbonate as buffer.

This buffer was based on the complex buffer system of egg albumen which contains 0.06-0.1 M bicarbonate ions (1, 8) in equilibrium with the carbon dioxide of the hen's blood. At the time of laying, albumen has a pH value of 7.5-7.6 which slowly rises to 9.0 or over as carbon dioxide diffuses out through the untreated shell. A reaction of pH 9.0 or over is also given by a 0.05 M solution of sodium carbonate which in the presence of 10.0% carbon dioxide is gradually converted to a 0.1 M solution of sodium bicarbonate with a pH value of 7.4-7.6. Since the albumen of commercially oiled eggs is usually quite alkaline at the time of oiling, carbonate rather than bicarbonate was used as the buffer in the test medium.

On exposure to the same concentration of carbon dioxide, the carbonate medium and egg albumen gave similar pH values (Table 1). By varying the concentration of carbon dioxide in the gas above the medium, agar with reactions similar to those of albumen from new-laid eggs (pH 7.5-7.6), unoiled eggs several days old (pH 8.9-9.7) and oiled eggs stored for various periods (pH 7.9-8.7) could be readily obtained. Petri plates containing 20 ml. of agar were inoculated by touching the centre of the plate with a needle dipped in the spore suspension. Incubation was at 100% R. H. When the effect of mold growth on the pH of the medium was investigated, agar was omitted in order to have a uniform pH throughout the medium. The surface of the carbonate broth was inoculated with a loopful of spore suspension.

Since the carbonate-bicarbonate buffer system was unstable in the absence of carbon dioxide, a glycine-sodium hydroxide buffer covering the pH range 7.5-10.0 was used to study the effect of pH on mold growth in the absence of carbon dioxide.

To observe the effect of carbon dioxide and pH on germination of spores from the 3 mold species, slide cultures were prepared using the agar media described above.

All material was incubated in vacuum desiccators which were placed in constant temperature rooms. The base of each desiccator contained water to give 99-100% R. H., or a saturated solution of ammonium sulphate to give 80% R. H. Small beakers of sterile carbonate agar and albumen were placed in the desiccators to determine the effect of carbon dioxide on pH in the absence of mold growth. When growth in the absence of carbon dioxide was investigated, small beakers of 20% potassium hydroxide containing filter paper wicks were placed in the desiccators to absorb carbon dioxide produced by the growing molds.

Carbon dioxide concentrations up to 10% were obtained as follows: air equal to 10.0% of atmospheric pressure was evacuated from each desiccator, the desired amount of carbon dioxide added and the difference in volume made up with nitrogen where necessary. Gas from commercial cylinders was used. This procedure gave a uniform oxygen concentration in all desiccators. Oxygen concentrations below 20.0% were obtained by a similar procedure of evacuation and refilling with nitrogen or, when the effect of reduced oxygen tension in the presence of carbon dioxide was studied, with carbon dioxide and nitrogen. Gas concentrations were checked every 2 or 3 days with an Orsat apparatus, and gas mixtures replaced as needed.

To accelerate the effect of experimental conditions the usual incubation temperature was 72° F. (22° C.). Mold growth on all media was examined at 2- or 3-day intervals for a maximum period of 21 days. One set of plates was incubated at 35° F. (1.7° C.) to duplicate commercial cold storage conditions, and the incubation period was then extended to 18 weeks with measurements made every 4 weeks.

TABLE 1

Effect of mold growth on the pH of albumen after 13 days and of carbonate broth after 7 days at 72° F.

Concentration of carbon dioxide %	pH [1]							
	Albumen				Carbonate broth			
	Sterile	*S. carnis*	*C. herbarum*	*P. expansum*	Sterile	*S. carnis*	*C. herbarum*	*P. expansum*
0	8.9	8.7	8.7	8.6	9.0	8.6	8.0	7.9
2.5	8.1	8.1	8.1	8.0	7.8	7.8	7.6	6.8
5.0	7.8	7.7	7.8	7.5	7.5	7.5	....	6.9
7.5	7.6	7.5	7.5	7.3	....	....	....	....
10.0	7.4	7.4	7.5	7.2	7.2	7.2	7.2	6.7

[1] Initial pH—Albumen, 9. 0
Carbonate broth, 9.3

The amount of growth on air cell membranes both *in situ* and excised, and on the surface of albumen was estimated visually. The diameters of mold colonies on agar plates were measured and the results expressed as the average diameter in mm. of 5 colonies. The effect of carbon dioxide and pH on spore germination was followed by microscopic examination of slide cultures of the 3 molds. pH values were determined with a Beckman pH meter.

RESULTS

Molds growing on exposed air cell membranes of otherwise intact eggs showed little difference in response to various carbon dioxide concentrations (see Methods), but considerable inhibition of growth occurred when the oxygen concentration was lowered to 5.0%. Flat pale colonies typical of air cell mold were found on both membranes and agar whenever the atmosphere contained less than 1.0% oxygen. The inhibiting effect of low oxygen concentrations was not influenced by the amount of carbon dioxide present.

However, carbon dioxide had a marked effect on the 3 mold species when they were grown on the surface of egg albumen or on pieces of air cell membrane floating on albumen (Table 2). In the absence of carbon dioxide, i.e. at pH 9.0 or over, there was a very small amount of stunted growth. As the carbon dioxide concentration increased to between 5.0 and 10.0%, i.e. at pH 7.8-7.4, the amount of growth and degree of sporulation reached a maximum. The type of growth resembled that found in eggs with air cell mold. Growth was more profuse on the albumen than on the membranes, but even heavy mold growth did not significantly lower the pH of the albumen beyond the decrease produced by carbon dioxide (Table 1). Because the experimental conditions closely approximated the environment of the air cell with optimum humidity and freedom from external contamination, it is reasonable to assume that a similar response to carbon dioxide occurs in the air cell of the intact egg.

At both 72° F. and 35° F. growth of the 3 molds on carbonate agar was also stimulated by all concentrations of carbon dioxide (Figures 2 and 3). There was very little growth in the absence

TABLE 2

Effect of carbon dioxide on mold growth on egg albumen and on air cell membrane floating on albumen after 13 days at 72° F.

Concentration of carbon dioxide %	Albumen			Membrane		
	S. carnis	*C. herbarum*	*P. expansum*	*S. carnis*	*C. herbarum*	*P. expansum*
0	+	++	++	+	+	+
2.5	++	+++	+++	++	+++	+++
5.0	+++	++++	++++	+++	+++	+++
7.5	++	++++	++++	+++	+++	+++
10.0	+	++++	++++	++	+++	+++

\+ — slight growth
++ — moderate growth
+++ — heavy growth
++++ — very heavy growth

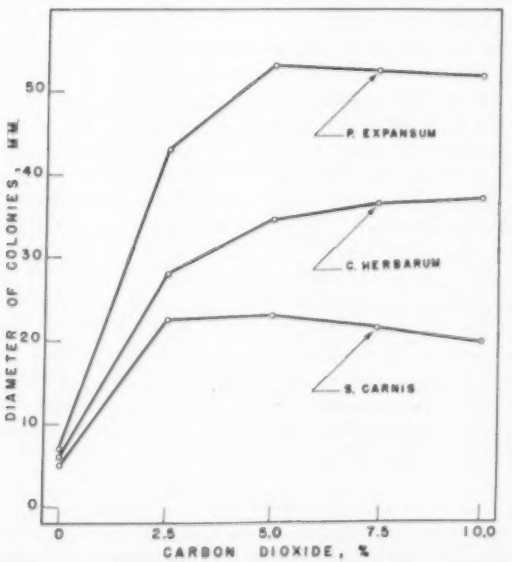

Figure 2. Effect of carbon dioxide concentrations from 0 to 10.0% on the growth of molds on carbonate agar after 16 days at 72° F. (22° C.).

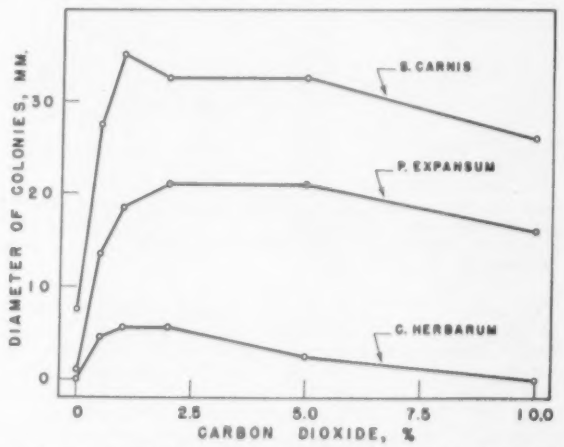

Figure 3. Effect of carbon dioxide concentrations from 0 to 10.0% on the growth of molds on carbonate agar after 18 weeks at 35° F. (1.7° C.).

of CO_2. Low carbon dioxide concentrations were slightly more effective at the lower temperature. Prolonged incubation enhanced the stimulating effect of low concentrations because the carbon dioxide gradually reduced the reaction of the medium to levels more favorable for growth. As the incubation period increased, acid from the fermentation of sugar in the medium also tended to obscure the differential effect of the various carbon dioxide concentrations (Table 1).

The appearance of mold colonies grown at both temperatures indicated that as little as 0.5% carbon dioxide produced marked stimulation of growth (Figures 4 and 5). Comparison of colonies

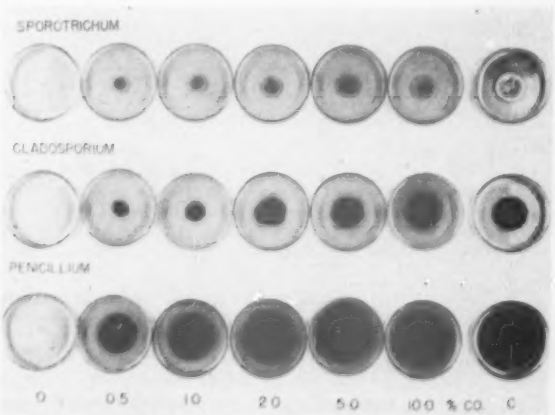

Figure 4. Effect of carbon dioxide concentrations from 0 to 10.0% on the growth and appearance of mold colonies on carbonate agar after 21 days at 72° F. (22° C.). Colonies (C) grown on the same medium without carbonate at pH 7.5 in the absence of carbon dioxide.

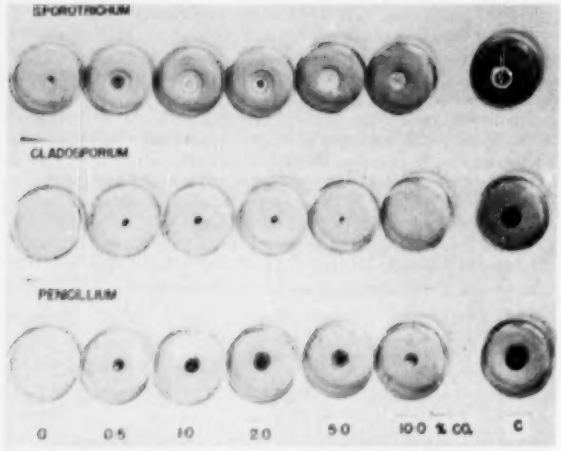

Figure 5. Effect of carbon dioxide concentrations from 0 to 10.0% on the growth and appearance of mold colonies on carbonate agar after 18 weeks at 35° F. (1.7° C.). Colonies (C) grown on the same medium without carbonate at pH 7.5 in the absence of carbon dioxide.

(C) grown at pH 7.5 on the same medium without carbonate in the absence of carbon dioxide showed that the carbonate buffer inhibited growth and sporulation of the three molds in varying degrees. Since data not included here showed that carbon dioxide in the absence of carbonate was not inhibitory, this toxic effect may be attributed solely to the carbonate buffer.

At 72° F. in the absence of carbon dioxide, the molds grew better at pH 7.5 than at higher pH values (Figure 6). The

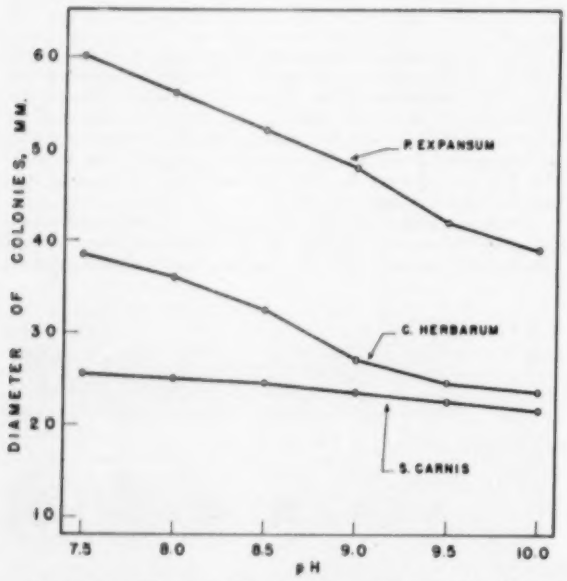

Figure 6. Effect of pH on the growth of molds on agar containing glycine-sodium hydroxide buffer after 21 days at 72° F. in the absence of carbon dioxide.

effect of pH alone was not as marked as that produced by changes in pH caused by carbon dioxide acting on the carbonate buffer. Several factors probably contributed to the relatively slight response of the molds to changes in pH. The glycine-sodium hydroxide buffer used in these experiments was less inhibitory than the carbonate buffer, particularly above pH 8.5. In addition, acid produced by the molds during growth and the instability of the buffer at high pH values shifted the reaction of the medium to levels more favorable for growth.

Examination of slide cultures showed that carbon dioxide did not affect germination and subsequent growth of spores from the 3 molds provided the original pH of the medium was near neutrality. When adequate oxygen was available (i.e., near edge of preparation), germination on agar at pH 9.0-10.0 was retarded, and growth after germination was poor, but if insufficient oxygen was present, germination was inhibited. However, in the presence of 10% carbon dioxide, germination and growth on alkaline medium was stimulated.

DISCUSSION

The stimulating effect of low carbon dioxide concentrations on mold growth *(4, 10)* has already been mentioned. Tomkins *(10)* also pointed out that storage of food products in concentrations of carbon dioxide up to 20.0% might, under certain conditions, encourage rather than restrict the growth of some molds by changing the pH. Previous work *(7)* has shown that the average carbon dioxide concentration in the air cells of mold-free commercially oiled eggs was less than 1.0% and about 2.0% in day-old eggs oiled in the laboratory. Eggs with air cell mold or incipient bacterial spoilage often contained as much as 10.0% carbon dioxide. The results obtained in the present investigation indicated that, even at cold storage temperatures, very low concentrations of carbon dioxide stimulated mold growth on albumen, air cell membranes floating on albumen, and on an alkaline medium resembling egg albumen. Therefore, since the air cells of oiled eggs frequently contained sufficient carbon dioxide to stimulate germination and subsequent growth of contaminating mold spores, retention of carbon dioxide by the oiled shell appeared to be the most important factor contributing to the development of air cell mold.

There are probably several stages in the development of air cell mold. Mold spores, or perhaps hyphae from surface mold growth, must penetrate the shell and membranes to reach the air cell. Very little growth is likely to occur in the alkaline environment of the unoiled egg, but carbon dioxide in the air cell of the oiled egg maintains the albumen at a lower pH and favors spore germination and early development of hyphae. Since gas exchange through the oiled shell is limited, the growing colony is further stimulated by its own production of carbon dioxide and rapidly consumes the available oxygen. Because the highest concentration (10.0%) of carbon dioxide likely to occur in eggs with air cell mold is not inhibitory, lack of oxygen rather than inhibition by excess carbon dioxide seems to be responsible for the small size, stunted appearance and poor sporulation of most air cell mold growth. This conclusion is supported by observations on the oxygen requirements of molds *(3, 5)*, the low oxygen content of gas from eggs with air cell mold *(7)* and the appearance of molds grown in less than 5.0% oxygen.

SUMMARY

The development of air cell mold in oiled eggs could not be related to external factors such as handling methods, local conditions or storage temperature. How-

ever, at 72° F. carbon dioxide concentrations up to 10% stimulated mold growth on egg albumen and on air cell membranes floating on albumen by lowering the pH to levels favorable for growth. At 72° and 35° F. very low concentrations of carbon dioxide stimulated mold growth on carbonate agar which reacted with carbon dioxide in the same manner as egg albumen. Low oxygen concentrations produced flat pale growth typical of air cell mold.

The carbon dioxide content of the air cells of oiled eggs was often sufficient to stimulate germination and growth of contaminating mold spores by lowering the pH of the albumen, and the depletion of oxygen in the air cell by the developing mold colony produced the stunted growth found in eggs with air cell mold.

Acknowledgments

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Effects of Simulated Transit and Marketing Periods on Quality of Florida Oranges[a]

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Changes that take place in the composition and flavor of Florida oranges during simulated commercial shipping and marketing periods are reported. Data on ascorbic acid, total solids, total acids, and flavor tests are furnished.

During recent years attention has been given to the maintenance of quality in fruits. Research findings have emphasized the effects of methods of handling and refrigeration to nutritive values, shelf life, and spoilage *(4, 7, 8, 9)* with the result that considerable improvement has been made in marketing practices. The purpose of the present study was to determine the effects of the transit and marketing periods on composition and flavor of Florida oranges.

MATERIALS AND METHODS

Tests were made with Pineapple and Valencia oranges. The fruit was obtained from 7 different commercial packing houses and consisted of 21 lots of graded fruit sizes 176, 216, and 288. In addition to the tests with these, 5 other tests were made with large samples of ungraded fruit. The latter was obtained from different frozen citrus concentrate companies and the oranges were taken at random from the belt just prior to the extraction of juice. Each of the lots of oranges was divided into subsamples and chemical analyses were made at specified intervals on the composited juice of each subsample. Each subsample of graded sized fruit consisted of 50 oranges, while each subsample of ungraded unsized fruit consisted of 100 oranges. The analyses included determination of ascorbic acid (vitamin C), total solids (principally sugars), total acid (as citric), and flavor.

Official methods were followed in determining the chemical constituent *(1)*. Ascorbic acid content was determined by the method described by Bessey and King *(2)*. Essentially this

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TABLE 1

Effect of simulated transit and market temperatures on composition and flavor of oranges

Treatment	Pineapple Oranges [1] (Feb. 13, 1953)				Valencia Oranges [2] (March 6, 1953)			
	Ascorbic acid	Total Solids	Total acid	Flavor	Ascorbic acid	Total Solids	Total acid	Flavor
	Mg./Ml.	*Pct.*	*Pct.*	*Numerical rating*	*Mg./Ml.*	*Pct.*	*Pct.*	*Numerical rating*
None (at start)	.57	13.60	.91	86	.46	12.95	.97	88
3-day storage at 50° F.	.57	13.58	.89	....	.46	12.86	.95	....
6-day storage at 50° F.	.56	13.58	.86	....	.45	12.85	.95	....
3-day storage at 50° F. plus 7-day storage at 70° F.	.54	13.44	.81	....	.44	12.98	.92	....
6-day storage at 50° F. plus 7-day storage at 70° F.	.54	13.51	.81	87	.44	13.00	.88	90
LSD at 0.05	0.020	N.S.	.040	N.S.	.018	N.S.	.036	N.S.
LSD at 0.01	0.026	N.S.	.053	N.S.	.024	N.S.	.047	N.S.

[1] Each value is the mean of 8 lots of graded fruit (sizes 176, 216, and 288) and ungraded fruit (not sized random sample) from various sources.
[2] Each value is the mean of 10 lots of graded fruit (sizes 176, 216, and 288) and ungraded fruit (not sized random sample) from various sources.
N.S.—Not significant.

method consists of the titration of orange juice with a solution of sodium 2,6-dichlorobenzenoneindophenol (2,6-dichlorophenolindophenol) which had been standardized against fresh commercial crystalline ascorbic acid. Total water-soluble solids were determined with an Abbe (Bausch and Lomb) refractometer. Total acid was determined by the titration of orange juice with standard Na OH, using phenolphthalein as an indicator, the results being calculated as anhydrous citric acid.

Flavor ratings *(5)* were given by a panel of about 37 taste testers, of whom a majority were staff members of Biological Sciences Branch, Agricultural Marketing Service, Horticultural Crops Branch, and Entomology Research Branch, Agricultural Research Service, U. S. Department of Agriculture. This panel of taste judges rated Tangerines *(3)* and Temple Oranges *(6)* but during different years.

All juice samples were rated according to an arbitrary standard scale based on the score card reproduced elsewhere *(3, 5, 6)*.

In each test 50 to 100 oranges were used. Flavor ratings and chemical analyses were made on aliquots of the juice. Each judge was instructed to rate the lot but not discuss his ratings with other judges. Each judge individually appraised each lot of juice and gave a numerical rating, and the ratings of all judges were averaged for each lot.

Short transit periods were simulated by storage of fruit at 50° F. for 3 days, and long distance shipment by holding the fruit at this temperature for 6 days. Seven days' storage at 70° F. represented the marketing period. Tests were started on February 13, March 6, and April 14, 1953. The general results of the tests were fairly similar; therefore only the means for the first and third series of tests are shown. (Table 1).

RESULTS

Ascorbic Acid: Storage for 7 days at 70° F. caused a slight lowering of the ascorbic acid content of oranges (Table 1). Storage for 3 or 6 days at 50° F. did not significantly lower ascorbic acid content. Although statistical treatment of these data indicated that oranges lost some ascorbic acid during a simulated shipping and retail display period, it appears doubtful that the amount of loss was great enough to be of practical significance.

Total Solids: The total solids content in the fruit showed no consistent change during the marketing period.

Total Acid: The total acid in the fruit consistently decreased during simulated transit and marketing periods.

Flavor: Flavor ratings were obtained only at the start and the end of the tests and no significant change in flavor was detected.

SUMMARY

These experiments were designed to determine the changes that take place in composition and flavor of Florida oranges during customary shipping and marketing periods. The data on ascorbic acid, total solids, total acid and flavor indicate that:

Oranges lost a very small amount of ascorbic acid, three milligrams or less per 100 ml. of juice during a simulated transit and marketing period consisting of 3 or 6 days at 50° F. and 7 days at 70° F.

No consistent change occurred in total solids of the fruit during the simulated shipping and marketing period. On the other hand, total acid consistently decreased during the 10- to 13-day period.

Flavor ratings made at the start and the end of the tests were virtually identical, the flavor being highly acceptable at both times.

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The Role of Trace Metal Contamination in the Discoloration of Glass Packed Baby Foods[a]

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The effect of trace quantities of metals on the discoloration rates of fruit and vegetable purées has been studied. No evidence of seepage of retort water into commercial glass containers under normal processing conditions could be detected. The analysis of 150 samples of retort water indicated that the levels of iron encountered were too low to constitute a significant source of iron contamination even if seepage of the water into the jars were to occur.

Findings published by Kohman and Cole *(3)* on the distribution of iron in samples of storage-darkened soups in baby food jars have led to the speculation that the higher iron content in the upper portion of the product was due to the diffusion of retort water into the jars during processing. These authors believed that the surface discoloration that developed in storage was due to the increased iron concentration in the upper layers of the contents.

A recent paper by Livingston, Esselen, and Fellers *(5)* pointed out that the surface discoloration of applesauce in commercial baby food jars was due to an oxidative reaction, which could be controlled only by limiting the amount of oxygen in the container. Other quantitative experiments by Vilece *(9)* on eight fruit and vegetable purées have confirmed this observation.

In the present report, four aspects of an investigation of the importance of trace metal contamination in the development of discoloration in stored glass-packed baby foods are summarized: (a) the effect of trace quantities of added metals on the storage behavior of several purées; (b) the iron content of samples of darkened and undarkened puréed foods; (c) the levels of iron in samples of retort water obtained from 14 major baby food plants in New York, Pennsylvania, Illinois and California; and (4) the permeability of three types of baby food jars and four types of closures to aqueous transfer during processing.

EXPERIMENTAL PROCEDURES

Effect of added metals on baby food discoloration. Purées were made from fresh carrots, green beans, beets, spinach, apples, peaches, pears, and squashes. Each product was washed, trimmed (cored and peeled if necessary), cut, steamed to soften, and comminuted using a small hand-operated household mill. Sufficient amounts of aqueous solutions of $FeCl_3$, $CuCl_2$, $AlCl_3$, and KCl were added to different lots of purée to provide 2 levels of metal concentration, i.e., 10 and 20 p.p.m.

The prepared purées were deaerated by vacuumization, and 10-ml. portions filled into glass test tubes (15 mm. x 125 mm.) by means of a wide bore pipette. The tubes were drawn to a capillary, and their headspace gas content was adjusted by placing them in a desiccator connected to a vacuum pump and nitrogen supply. By evacuating the chamber to a given pressure level and releasing the vacuum with nitrogen gas, it was possible to introduce any desired gas mixture into the headspace of the test tubes. In this experiment, an oxygen concentration of 6.4% was attained as shown by analysis of the headspace gas using the method described by Lewis *(4)*. Upon removal from the chamber, the ends of the capillaries were immediately sealed in an oxygen torch and heat-processed to prevent spoilage. The vegetable purées were held at 240° F. (115.5° C.) for 15 minutes, and the fruit purées were heated at 212° F. (100° C.) for 15 minutes.

The effect of added metals on discoloration was determined by measuring the light reflectance of the purées immediately after processing and at intervals during storage using a Photovolt Model 610 Reflection Meter[c] in the manner described by Livingston and Vilece *(6)*. Munsell paper standards were used in calibrating the instrument. Standard No. 5YR ¼ was set to 100% reflectance for all purées except peach purée, for which color standard 5Y ¼ was used to set the instrument on 100%. White light was used in all cases.

Trace iron content of puréed food. Iron content was determined by a modification of the methods of Saywell and Cunningham *(7)* and Bandemer and Schaible *(1)*.

"A 2 to 10 g. sample of purée was weighed out in a calibrated 50-ml. Erlenmeyer flask, dried under vacuum, and wet ashed as follows: The dried food sample was covered with 1 to 2 ml. of concentrated H_2SO_4 and 2 ml. of concentrated HNO_3, allowed to stand for a time, then heated gently until charring commenced; HNO_3 was added dropwise until foaming and charring ceased. Digestion was completed by adding 70% $HClO_4$ dropwise until a colorless liquid was obtained. The samples were evaporated, rinsed with demineralized water, and evaporated again. Short lengths of large diameter tubing drawn down at one end served as covers for the digestion flasks. This permitted acids to be added without removing the covers, and spattering was kept to a minimum.

The samples were diluted with demineralized water to 50 ml. in the calibrated digestion flasks, and 10- or 15-ml. aliquots were transferred to 25-ml. volumetric flasks for analysis. One milliter of saturated solution of ortho-phenanthroline, 1-ml. of 10% hydroxylamine hydrochloride, and 2 ml. of 25% sodium citrate were added in that order. The pH was adjusted to about 5.0, with NH_4OH or dilute HCl, using a small square of Congo Red as an indicator. The samples were diluted to mark and allowed to stand an hour or more for full color development, before reading at 490 mμ on an Evelyn photoelectric colorimeter.[d] The iron content of the samples was easily calculated by reference to standard solutions of $FeCl_3$. Reagent blanks were carried throughout the entire procedure.

Samples of apple, beet, carrot, and green bean purée were analyzed for their iron content using the above-described method. Samples were selected to provide a variety of factors that could influence the iron content. Accordingly, commercial and laboratory samples of fresh and storage-darkened purées were analyzed. Relatively few jars could be obtained whose caps, on microscopic examination, did not reveal some evidence of breaks in the enamel.

To determine whether any correlation existed between ring discoloration and iron content in samples packed in all glass containers, test tubes of applesauce, carrot purée, and green bean purée, exhibiting different levels of storage discoloration were also analyzed.

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[a] This is Contribution No. 914, Massachusetts Agricultural Experiment Station.

[b] Present address: University of Florida, Gainesville, Florida.

[c] Manufactured by the Photovolt Corporation, 95 Madison Ave., New York 14, N. Y.

[d] Manufactured by the Rubicon Company, 29 North Sixth Street, Philadelphia, Pa.

In all instances, upper and lower portions of jar or tube content were removed separately and carefully kept apart. To sample the tubed purées, the contents were frozen, the glass broken, and sections of the frozen purée cut off for analysis. Careful laboratory technique, to prevent metal contamination, was exercised throughout the sampling and analysis. All glassware was washed with hot HNO_3, rinsed with demineralized water until chemically clean, and protected against dust.

Iron content of retort water from commercial baby food packing plants. One hundred fifty samples of retort water were obtained from 14 major baby food plants in the United States. The samples were collected and shipped in HNO_3-washed polyethylene bottles and, upon receipt by this laboratory, were analyzed for their iron content, by the method described above, omitting the digestion procedure.

Simmons, Monagham, and Taggart *(8)* had success with a similar method for determining very low (0.01 to 0.002 p.p.m.) concentrations of soluble iron in sea water.

The solid matter of several retort water samples from each plant was examined microscopically for iron as described by Chamot and Mason *(2)*. A portion of the residue was placed on a slide, moistened with a drop of concentrated HNO_3, and evaporated to dryness on a hot plate. The dry residue was moistened with water and a small amount of powdered potassium ferrocyanide was added. A dark blue flocculent precipitate indicated the presence of iron. Where retort water residues were found to contain appreciable amounts of iron, they were dissolved and quantitatively analyzed.

Retort water seepage in processing. Several means of determining whether retort water will diffuse into baby food jars during processing were studied. They included (a) the retorting of distilled water in baby food jars and subsequent iron analysis to determine whether any iron from retort water had been transferred; (b) the processing of distilled water in baby food jars in retort water containing added iron and subsequent analysis of sample; (c) the processing of baby food jars containing distilled water in retort water with added fluorescein and subsequent fluorimetric determination of the water in the jars; and (d) the processing of baby food jars containing silver nitrate solution in retort water with added salt. Results of these experiments were either negative or inconclusive; a more sensitive method, therefore, was developed for the final large-scale runs. In this method, baby food jars were thoroughly washed until chemically clean and filled with a known amount of demineralized water (conductivity grade). The jars were capped with washed closures by a steam-flow vacuum-sealing machine, and processed in a 20-gallon vertical retort filled with a saturated NaCl solution. The electrical resistance of the water in the jars was measured before and after processing, using a Model 630 Triplett Volt-Ohm-Ammeter,* illustrated in Figure 1.

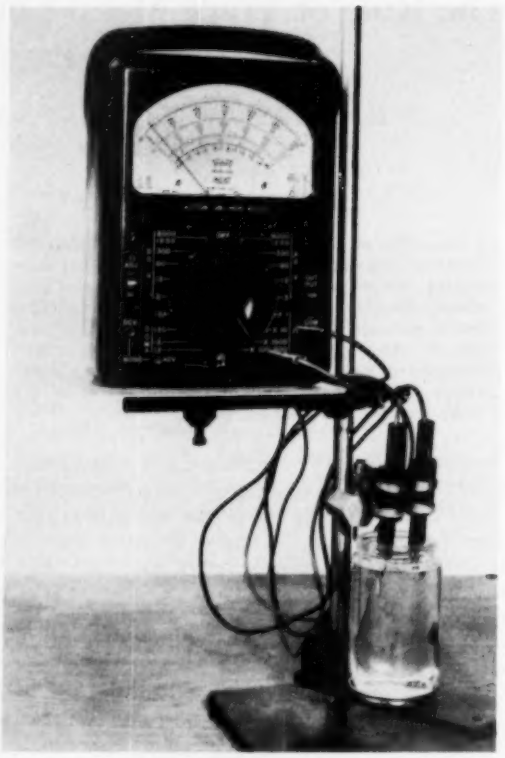

Figure 1. Apparatus for measurement of the electrical resistance of water in baby food jars.

RESULTS AND DISCUSSION

Effect of added metals on baby food discoloration. The measurement of reflectance of purées with added metallic ions indicated an increase in darkening in storage. Although small but regular decreases in the reflectance of the upper portions of the purées in the tubes were present, the very slight changes in reflectance of the lower portions of the food did not seem to follow a regular pattern. Table 1 summarizes the results of the observations made on tubes of purée stored for 28 days at about 85° F. (29.4° C.). Data indicate the "effective ring browning" of the purées, i.e., the difference in percent between the reflectance of the upper and the lower portions of the contents of a tube.

It may be seen from these results that the addition of metals, in the concentrations used, caused a somewhat increased darkening of certain of the purées. Iron appears to promote the darkening of apple, beet, and pear purée to a slight degree, and copper gives a similar effect when added to peach, pear, and squash purée.

Although there has been no evidence to indicate that metallic ions are a requisite for this type of discoloration, the over-all results of these experiments do not bear out the marked pro-darkening effect that was anticipated on the basis of known reactivity of copper and iron in foodstuffs. A possible explanation for this effect may be that the products tested contained enough of these metals initially to promote any darkening that occurred, so that the later addition of the metals did not materially affect the rate of the discoloration reactions.

Trace iron content of puréed foods. The results of iron analyses carried out on 24 random samples of apple, beet, carrot, and green bean purées packed in baby food

TABLE 1

Ring discoloration (% decrease in reflectance) in food purées containing added metals, stored for 28 days at about 85° F. (29.4° C.)[1]

Product	Metal added (p.p.m.)							
	None	Al+++		Cu++		Fe+++		K+	
		10	20	10	20	10	20	10	20
Apple	8.4	8.0	6.0	5.8	6.2	14.2	14.7	8.2	7.3
Beet	12.2	16.3	16.0	12.2	16.3	16.7	15.5	16.2	13.2
Carrot	17.2	14.7	14.2	16.0	15.3	18.7	16.7	17.8	16.0
Green bean	18.0	16.3	15.2	15.5	14.5	19.2	17.8	16.3	18.0
Peach	5.9	6.8	6.8	8.3	8.3	6.4	5.2	7.5	6.2
Pear	5.3	5.3	4.0	8.8	9.0	7.3	6.7	4.8	3.5
Spinach	0	1.0	0.7	0.8	0.8	1.3	−0.5	0.7	0.7
Squash	5.9	6.8	6.8	8.3	8.3	6.4	5.2	7.5	6.2

[1] Each datum represents an average value from triplicate tubes. Six tubes of each food were used for controls.

* Manufactured by the Triplett Electrical Instrument Co., Bluffton, Ohio.

jars, are presented in Table 2. Five of the samples analyzed were from experimental packs, the remainder being fresh and storage-browned commercial samples purchased on the open market. The degree of discoloration was visually rated by a method similar to that described by Kohman and Cole *(3)*, in which:

0 = no discoloration
1 = trace discoloration
2 = slight discoloration
4 = marked discoloration

The condition of the caps, as revealed by microscopic examination, was similarly described by:

0 = no visible defect
1 = roughness or micro-break. No evidence of corrosion
2 = pinhole in enamel or localized corrosion
4 = extensive corrosion

Vacuum measurements were made with a gauge that corrects for headspace volume dilution. Although not indicated herein, it should be noted that moisture analyses on top and bottom portions of many samples analyzed for iron were also carried out to determine whether heavier solids might settle sufficiently to influence the iron concentrations within the jars. The results of these analyses indicate that there is generally little difference in the solids content of the purées; moreover, any differences that were found could not be correlated with the iron distribution. The results, as summarized in Table 2, indicate that although a correlation between ring darkening and top to bottom iron differential exists, there is also a correlation between cap corrosion and iron differential. This correlation is probably due to the fact that both discoloration and cap corrosion are functions of time, though not necessarily related. Table 3 summarizing the results of similar analyses conducted on 9 samples of purées stored in glass tubes reveals that in the absence of metallic contamination due to cap corrosion, there is no correlation between the iron distribution and storage darkening.

TABLE 3

Iron content of purées packed in glass tubes

Product	Degree of discoloration	Iron content ± 0.3 (p.p.m.)		
		Top	Bottom	Difference
Carrots	4	10.8	11.3	—0.5
Carrots	4	10.9	10.9	0
Apples	1	3.2	3.2	0
Apples	2	3.1	3.3	—0.2
Apples	1	2.4	2.4	0
Green beans	1	12.2	11.3	0.9
Green beans	2	15.3	15.1	0.2
Green beans	1	12.2	11.2	1.0
Green beans	1	11.7	11.8	—0.1

Iron content of retort water. The results of the analysis of retort water samples, summarized in Table 4, indicate that with one exception (plant No. 3) the average soluble iron content of samples submitted fell below 0.21 p.p.m. This clearly indicates that in most instances the retort water could not constitute a source of iron contamination, even if it were assumed that diffusion occurred in processing. Even at the highest soluble iron level found in any of the samples, i.e., 11.6 p.p.m., it would take nearly 5 ml. of retort water to raise the iron content of the upper 10 g. of food in a jar from 5 to 10 p.p.m., as reported by Kohman and Cole *(3)*. Experiments conducted in this laboratory showed that when $FeCl_3$ was used as a source of excess iron in retort water, it was difficult to maintain a concentration of over 10 p.p.m. of Fe in solution throughout the process period. Most of the iron salt that had been dissolved prior to processing was later recovered as a precipitated residue deposited on the walls of the retort. Since both the soluble and insoluble iron content of plant retort water samples submitted were far below the levels used in the experiments with $FeCl_3$ (in which no seepage was found) it would appear that commercial retort water could not possibly serve as a source of iron contamination for baby foods in glass jars, even if seepage into jars occurred.

Retort water seepage in processing. To check the sensitivity of the method adopted to determine whether salt-laden retort water could seep into baby food jars in

TABLE 2

Iron content of purées packed in glass jars

Product	Pack	Degree of discoloration	Cap condition	Vacuum (in.)	Iron Content ± 0.3 (p.p.m.)		
					Top	Bottom	Diff.
Carrots	expressed	4	4	—	10.8	5.2	5.6
Carrots	expressed	4	4	—	12.7	5.9	6.8
Carrots	expressed	4	4	—	9.9	3.6	6.3
Carrots	expressed	4	2	—	14.8	12.6	2.2
Carrots	expressed	2	2	—	3.3	2.6	0.7
Carrots	comminuted	0	1	26	2.5	2.9	—0.4
Carrots	comminuted	0	1	23	2.0	1.9	0.1
Carrots	comminuted	0	1	23	1.6	1.7	—0.1
Carrots	comminuted	0	1	24	1.9	1.9	0
Green beans	comminuted	2	1	25	5.5	5.4	0.1
Green beans	comminuted	2	1	23	6.1	6.1	0
Green beans	comminuted	1	0	21	5.8	5.8	0
Green beans	comminuted	1	1	—	5.7	5.4	0.3
Beets	comminuted	4	4	17	6.6	4.3	2.3
Beets	comminuted	2	2	18	4.1	3.7	0.4
Beets	comminuted	4	4	5	8.1	3.9	4.2
Beets	comminuted	1	0	26	4.5	4.7	—0.2
Apples	comminuted	0	0	26	1.0	1.6	—0.6
Apples	comminuted	0	0	26	1.4	1.3	0.1
Apples	comminuted	0	0	26	2.4	2.4	0
Apples	comminuted	0	0	27	1.8	1.7	0.1
Apples	comminuted	1	1	27	1.0	0.8	0.2
Apples	comminuted	1	1	26	0.9	1.3	—0.4
Apples	comminuted	0	0	25	2.1	2.4	—0.3

TABLE 4
Iron content of retort water from commercial baby food plants

Plant	State	No. of samples	Iron content (p.p.m.)			
			Soluble		Insoluble (max.)	Total (max.)
			Range	Average		
1	California	11	0.05-0.5	0.14	....	0.5
2	California	12	0-0.1	0.035	0.5	0.6
3	California	12	4.1-11.6	8.20	5.0	16.6
4	California	11	0-0.1	0.05	....	0.1
5	California	11	0-0.3	0.004	1.8	2.1
6	California	3	0.01-0.13	0.066	....	0.1
7	Illinois	12	0.005-0.06	0.024	....	0.1
8	New York	12	0-0.18	0.075	0.3	0.5
9	New York	12	0.08-0.97	0.21	....	1.0
10	New York	12	0.03-0.7	0.15	0.1	0.8
11	New York	10	0.02-0.8	0.15	1.0	1.8
12	New York	10	0.05-0.4	0.15	....	0.4
13	Pennsylvania	11	0.03-0.1	0.065	....	0.1
14	Pennsylvania	11	0.08-0.17	0.11	....	0.2
Average (all plants)				0.673	0.6	1.8
Average (excluding plant No. 3)				0.094	0.3	0.6

processing, increments of saturated brine were added to several jars containing demineralized water. The effect of exact volumes of the brine upon the resistance of the water is graphically represented in Table 5. It

TABLE 5
Effect of added saturated brine on the resistance of distilled water in baby food jars

Ml brine added per jar	Resistance in ohms
0	900,000
0.01	100,000
0.02	50,000
0.03	35,000
0.04	30,000
0.05	27,500
0.10	23,000
0.50	14,500
1.00	12,000

may be seen that the addition of 0.01 ml. of brine to the 130 ml. of water in a baby food jar had the effect of lowering the resistance of the water from an average of 900,000 ohms to about 100,000. The addition of 0.10 ml. brought the resistance down to about 23,000 ohms, whereas a 1.00 ml. addition gave a resistance of 12,000 ohms. Table 6 summarizes a test run carried out on

TABLE 6
Resistance of distilled water in baby food jars processed for 30 minutes at 250° F. (122° C.)

Make of container	Make of closure	Resistance (in ohms)		
		Initial	After processing	
			In tap water	In brine
A	A-1	900,000	500,000	550,000
A	A-2	900,000	500,000	700,000
B	B	700,000	500,000	650,000
C	C	900,000	700,000	850,000

three makes of baby food glass containers, and four types of appropriate closures (including closures used in experimental packs of purées that underwent storage discoloration). One hundred twenty-five jars were involved in the particular run illustrated. The data indicate that there is no evidence of salt penetrating into the containers even in the minutest quantities. On the basis of molecular dimensions, it would be reasonable to expect that sodium chloride could diffuse as readily as any iron compound under circumstances where iron diffusion occurs. It would, therefore, appear that under normal processing conditions, there is little likelihood of iron contamination of products in baby food jars.

The slight decrease in resistance by the water in all jars during processing is undoubtedly due to the leaching out of ionic constituents from the container or the closure. This becomes readily apparent when one compares the decrease in resistance in jars processed in brine with that in jars processed in tap water.

SUMMARY AND CONCLUSIONS

The effects of trace quantities of four metals on the discoloration rates of eight stored vegetable and fruit purées have been studied. Iron and copper were found to exert a slight pro-darkening effect on apple, beet, and pear, and peach, pear and squash purées, respectively.

Fruits and vegetable purées packed and held under different conditions exhibited different levels of discoloration. Analyses of such purées showed that although an increased iron content of the upper layers of any sample seems to be related to cap corrosion, ring discoloration can occur in the absence of excess surface iron.

Experiments were conducted to determine whether commercial glass containers, under normal processing conditions, would allow seepage of retort water. No trace of the occurrence of such seepage could be detected, although the method used was sensitive to amounts as small as 0.01 ml.

The analysis of 150 samples of actual retort water obtained from 14 different baby food packers indicated that the levels of iron encountered were too low to constitute a source of iron contamination in baby foods, even in the remote event that seepage were to occur and escape notice.

Acknowledgments

The authors are deeply indebted to the Anchor-Hocking Glass Company and the Glass Container Manufacturers Institute for their help in procuring the samples of retort water used in this study. The cooperation of all the baby food packers concerned is greatly appreciated.

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Chemical Prevention of Black Spot (Melanogenesis) in Ice Stored Shrimp

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Several different chemicals including sodium sulfite and sodium bisulfite were used either as dips or in ice at various levels of concentration to depress black spot (melanin) formation in Gulf shrimp of the Peneaus setiferus variety. The quantity of sulfite remaining in shrimp after storage in ice containing sodium sulfite and sodium bisulfite was also determined.

The black bands and areas known as black spot which develop on shrimp a short time after they have been caught have been studied quite extensively in this laboratory. The biochemical basis for this blackening phenomenon is the autoxidation of certain chromogens of the phenol-amine type which are probably formed from the breakdown of shrimp protein. Since the black substances formed from the oxidation of these substances are called melanins, it has previously been suggested that shrimp containing black spots be referred to as melanotic shrimp *(2)*.

Since many shrimp fishermen remain at the shrimp fishing grounds as long as 2 weeks before returning to port with their catch, large quantities of shrimp presently brought to market are melanotic shrimp. Although the quality of these shrimp is not appreciably affected by the black spot formation, they are of poor appearance and are sometimes associated with spoilage. Thus, one of the major problems confronting the shrimp industry in Louisiana as well as other shrimp producing areas *(1)* has been the difficulty in preventing the development of black spot in shrimp while in ice storage. It was the object of these experiments, therefore, to investigate some of the possible practical chemical inhibitors of melanin formation.

EXPERIMENTAL METHODS AND RESULTS

All shrimp used in these studies were purchased in south Louisiana a few hours after they had been unloaded from the shrimp boats. They were well packed in ice and brought to the laboratory in Baton Rouge, where they were thoroughly washed in ice water and treated as described below:

Experiment 1. These shrimp were of the *Penaeus setiferus* specie, of mixed sizes, and were purchased the day they were caught. The washed shrimp were packed with ice in boxes (16 x 20 x 12 inches) and stored at 38° F. (3.3° C.) after the following treatment:

No. of shrimp in sample	Controls
50	I. Soaked for 5 minutes in sea water at 77° F. (25° C.)
50	II. Soaked for 5 minutes in fresh water at 77° F. (25° C.)
	Experimental
50	I. Soaked for 5 minutes in 1% sodium sulfite in sea water at 77° F. (25° C.)
50	II. Soaked for 5 minutes in 1% sodium sulfite in fresh water at 77° F. (25° C.)

The shrimp were removed from the boxes every 2 days and examined for black spot formation. They were then replaced in ice and re-stored.

The results of this experiment are presented in Figure 1, which shows the relationship of the percentage of shrimp developing melanosis with ice storage time. The shrimp soaked in fresh water were better protected than those soaked in sea water—probably because of the bacteria present in the sea water. Sodium sulfite in both sea water and in fresh water protected the shrimp quite well until the sixth day of storage. In no instance was the black spot formation on the sulfiite treated shrimp as pronounced as was that of the controls. In most cases, only one or two very slight black spots had formed on the sulfite treated

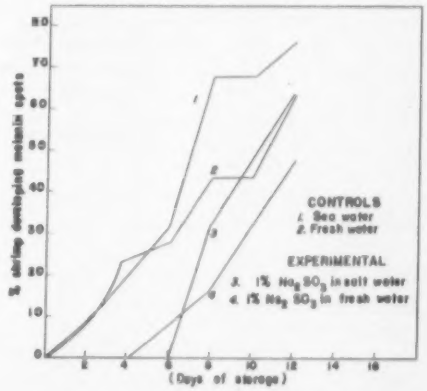

Figure 1. Relationship between the percentage of shrimp developing melanosis and the length of ice storage in experiment 1.

shrimp. On the other hand, the controls developed several pronounced spots on each shrimp. Thus, the graphic relationship in Figure 1 is not truly indicative of the degree of protection afforded by treatment with sodium sulfite.

Experiment 2. These shrimp were of the *Penaeus setiferus* variety having a count of 43 per pound, and were purchased the day after they had been caught. The largest shrimp were removed, washed and packed as were those in the preceding experiment. They were treated as follows:

No. of shrimp in sample	
155	I. Packed in ice containing 0.25% sodium sulfite.[a]
50	II. Soaked for 10 minutes in 1% "ascorbic-citric acid mixture 8-92"[b] and packed in pure ice.
70	III. Soaked for 10 minutes in 1% Rochelle salt and packed in pure ice.
40	IV. Soaked for 10 minutes in 0.50% ascorbic acid and packed in pure ice.
76	V. Soaked for 10 minutes in 1% citric acid and packed in pure ice.
50	VI. Control—Soaked for 10 minutes in water and packed in pure ice.

[a] A 0.25% solution of sodium sulfite was made using tap water as the solvent and frozen by adding small increments of the solution to a dishpan and freezing at —40° F. (—40° C.). This ice was stored at 0° F. (—17.8° C.) until the day it was used when it was chopped into small pieces, well mixed, and warmed to 30.2° F. (—1.0° C.) at room temperature.

[b] Kindly supplied by Pfizer and Co. Inc., New York.

The results of this experiment are given in Figure 2. Shrimp packed with 0.25% sodium sulfite ice clearly supplied the best protection against melanin formation. Those treated with 1% "ascorbic-citric acid mixture 8-92" were protected slightly better than untreated shrimp for the first 8 days, but there was no significant difference in total protection after 12 days of storage. Shrimp treated with 1% citric acid were slightly protected from discoloration while those treated with 0.5% ascorbic acid were preserved fairly well until the fourth day of storage. "Ascorbic-citric acid mixture 8-92" and ascorbic acid treated shrimp retained their blue color and did not have off odors of trimethylamine for 9 days of storage. After 10 days of storage all shrimp had lost their fresh color and smelled strongly of trimethylamine with the exception of those that were stored in the sulfite ice. The latter shrimp still maintained their fresh color and were completely odorless on the twelfth day of storage and had only

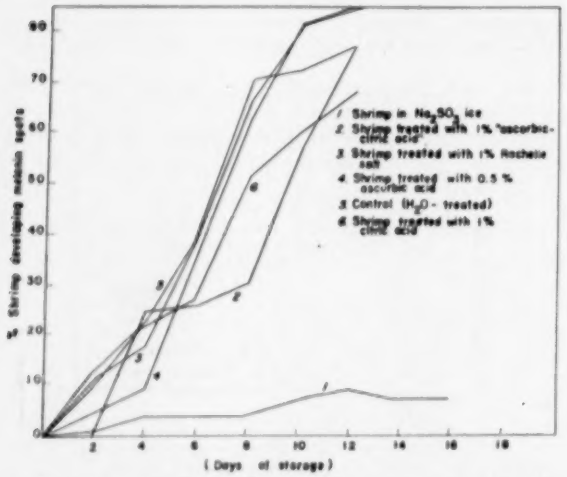
% Shrimp developing melanin spots
(Days of storage)
1 Shrimp in Na_2SO_3 ice
2 Shrimp treated with 1% "ascorbic-citric acid"
3 Shrimp treated with 1% Rochelle salt
4 Shrimp treated with 0.5 % ascorbic acid
5 Control (H_2O - treated)
6 Shrimp treated with 1% citric acid

Figure 2. Relationship between the percentage of shrimp developing melanosis and the length of ice storage in experiment 2.

slight off odors after 14 days of storage. The majority of these shrimp were still as firm as they were the day they were packed and did not have the usual fishy slime that prevails in shrimp that have been packed in pure ice 14 days or longer.

Experiment 3. This experiment was designed to compare the degree of protection afforded against melanosis by: (a) 0.25% sodium bisulfite ice; (b) 0.25% sodium chloride ice and; (c) pure ice. The shrimp were *Penaeus setiferus* of mixed count and were purchased one day after they had been caught. Two hundred shrimp were washed and packed in each of three separate boxes (16 x 20 x 12 inches) and stored at 38° F. (3.3°C.). They were removed from the boxes once every 2 days and examined for melanosis. Figure 3 shows the results of this experiment.

Shrimp packed in sodium bisulfite ice were almost perfectly protected from melanosis for the 14 days of storage. Shrimp packed in sodium chloride ice afforded better protection from melanosis than did the pure ice. The black spots that developed on the shrimp packed with bisulfite were barely detectible, and rarely exceeded more than one spot on each shrimp. There was only one well developed black spot on the shrimp of this group. These shrimp were completely odorless after being stored for 12 days in the bisulfite ice and had only slight spoilage odors after 14 days of storage. They were still firm after this storage period and had not accumulated the slimy condition previously mentioned. Those stored in sodium chloride ice were not as well protected from the development of melanosis and had slight odor of spoilage on the tenth day of storage.

Experiment 4. In order to determine the quantity of sulfite retained in the shrimp after storage under sodium bisulfite ice, shrimp from the same lot used in Experiment 3 were packed in

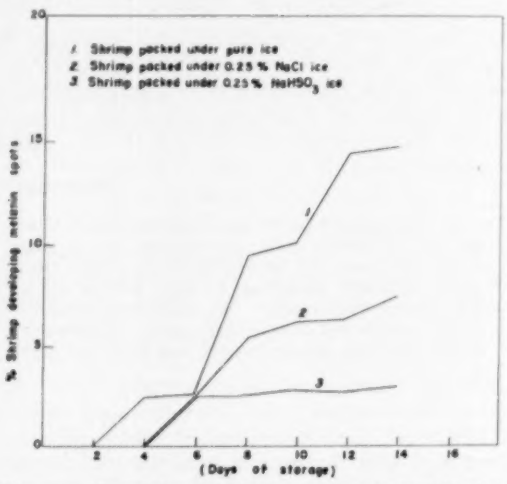
1 Shrimp packed under pure ice
2 Shrimp packed under 0.25 % NaCl ice
3 Shrimp packed under 0.25 % $NaHSO_3$ ice
% Shrimp developing melanin spots
(Days of storage)

Figure 3. Comparison of black spot development in shrimp packed under pure ice with that of shrimp packed under salt ice and sulfite ice.

0.25% sodium bisulfite ice and left undisturbed for 5 days. The following quantities of sulfite were determined by the method of Monier-Williams *(4)*, as modified by Thompson and Troy *(5)*:

	$SO_3^=$ (mg./100 g. shrimp)
I. Shrimp analyzed immediately after unpacking with shells intact and without washing	42.8
II. Shrimp boiled in 1% sodium chloride water for 8 minutes, shell free tissue analyzed	30.6
III. Shrimp thoroughly washed, the shells removed and the tissue analyzed without cooking	25.6
IV. Same as III, except shrimp were cooked for 8 minutes in 1% sodium chloride water	23.4
V. Same as II, except two teaspoons of vinegar were added to the cooking mixture	19.6

The average concentration of sulfite ($SO_3^=$) in unwashed, uncooked shrimp that had been stored for 14 days in 0.25% sodium bisulfite ice in Experiment 3 was 117.3 mg./100 g. of shrimp and was 50.6 mg./100 g. of shrimp after the shrimp had been washed and boiled for 8 minutes in 1% sodium chloride.

DISCUSSION

The formation of melanin pigment ordinarily depends upon the availability of three substances: (A) a suitable substrate [usually tyrosine or dihydroxyphenylalanine (dopa)], (B) molecular oxygen and (C) the enzyme tyrosinase (a copper-protein complex). If any of these substances are absent, the formation of melanin is impaired *(3)*.

Since the necessary substrates are probably formed from both bacteriological and enzymatic breakdown of protein in shrimp, a decrease in the available bacteria would aid in decreasing melanogenesis. This naturally could be accomplished by adding some bactericide.

Under the conditions of ice storage, autoxidation can not be completely alleviated because of the presence of circulating air, but a few substances are more readily oxidized by atmospheric oxygen under certain conditions and can be used to depress oxidation of tyrosine and dopa to melanins by being preferentially oxidized themselves.

Probably the most feasible method for preventing melanogenesis in shrimp is to inhibit the enzymatic activity, and since the co-enzyme of tyrosinase is a copper-proteid complex, it is reasonable to assume that any material that sequesters copper will reduce the normal enzymatic formation of melanin. Chemicals used in this respect for the prevention of melanin formation must necessarily be of non-toxic nature and must not impair the flavor of the food product. Thus the number of desirable chemicals available for commercial use in preventing melanin formation in shrimp are limited.

From this discussion, it can readily be seen that sulfite retards melanin formation in shrimp by three possible mechanisms; firstly, it sequesters some of the copper in the enzyme system and thus retards the enzymatic oxidation *(3);* secondly, it decreases the number of microorganisms which depresses proteolytic destruction *(1);* and thirdly, it is oxidized to sulfate in preference to the melanin substrates.

One-quarter percent sodium chloride ice keeps the shrimp slightly colder than pure ice by having a lower freezing point, and thus probably depresses bacterial and enzymatic breakdown of shrimp protein. The slight protection from black spot formation offered by salt ice adds to the advantages of making ice aboard the shrimp boats from sea water. This procedure not only saves the expense of buying pure ice, but also preserves the shrimp in slightly better condition during storage.

The chemicals other than the sulfites were used in attempts to decrease black spots because of their ability either to lower the pH from the optimum for activity of the enzyme system, or to complex copper ions. Also, tyrosinase preparations show a rapid loss of copper when subjected to dialysis below pH 3-4 *(3)*.

There are decided advantages as well as disadvantages in using sulfite ice for storing shrimp; sulfite ice greatly depresses melanogenesis in shrimp, it keeps them slightly colder than ordinary ice and decreases the number of bacteria, thus lengthening their storage life. Shrimp stored under 0.25% sulfite ice retain their natural colors for longer periods of time and the sulfite also prevents off odors for longer periods. On the other hand, certain areas of the shrimp touching sulfite ice are bleached. These areas become brown when the shrimp are cooked and are slightly tougher than other parts of the shrimp. Sulfite is absorbed by shrimp tissue and cannot be completely washed out by the normal processes of handling, cooking, or canning. The values for sulfite retained by shrimp reported here are believed, however, to be maximal since the normally processed shrimp at any commercial plant would be washed more thoroughly than were those examined in these experiments.

These disadvantages would naturally be lessened by using lower concentration of sulfite in the ice. Smaller sulfite concentrations would probably suffice to keep the shrimp in good condition, bleaching of the tissue would be decreased, and there would be smaller quantities of sulfite remaining in the shrimp after they had been processed. The use of smaller quantities of sulfite in ice used for preserving shrimp during storage is presently being investigated.

SUMMARY

Three different experiments were undertaken to determine the ability of certain chemicals to prevent black spot (melanin) formation in Gulf shrimp of the *Peneaus setiferus* species, and a fourth experiment was designed to determine the quantity of sulfite retained in shrimp that had been stored in 0.25% sodium bisulfite for 5 days.

Shrimp dipped in 1% sodium sulfite solutions and in 1% "ascorbic-citric acid mixture 8-92" solutions are slightly protected from black spot formation for about 8 days. One-half percent ascorbic acid solutions protect the shrimp from black spot formation for approximately 4 days. Shrimp treated with dilute "ascorbic-citric acid 8-92" and with ascorbic acid solutions maintain their natural colors and odors for approximately 9 days.

Shrimp packed in ice containing 0.25% sodium bisulfite and those packed in ice containing 0.25% sodium sulfite were protected almost perfectly from melanin formation for 14 days. These shrimp were completely odorless during the first 12 days of this storage period and maintained their natural colors. One-quarter percent sodium chloride ice also protected the shrimp fairly well from black spot formation, but not as well as the sufite ice.

Processing methods similar to those employed by commercial packing companies and by housewives failed to remove all of the sulfite from shrimp which had been packed in 0.25% sodium bisulfite ice for 5 days.

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Smoke Flavor and Ascorbic Acid as Preservatives for Fatty Fish

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Results of tests of smoke flavors to determine their preservative effect on fatty fish are reported. The fish were lightly salted and kept under refrigeration. The smoke flavors were tested alone and also in combination with ascorbic acid. Observations on the bacteriostatic effect of the smoke flavor on several typical organisms are also reported.

The chief cause of deterioration in fatty fish preserved either by freezing or by salting is the development of rancidity through oxidation of the highly unsaturated fat. Rancidity is hard to control in fish. The newly developed phenolic antioxidants such as nordihydroguaiaretic acid and butylated hydroxyanisol are practically insoluble in water; their uniform distribution over the fish surface is difficult. The more soluble gallic acid has not proved effective as an antioxidant for fish *(2)*.

Ascorbic acid has been reported by several workers to give an appreciable delay in rancidity in fish preserved at low temperatures *(4)*. Because of its water solubility it is easy to apply as an aqueous dip. However, ascorbic acid treatment has not consistently protected fish fillets *(2, 5)*. Furthermore, in artificial systems, ascorbic acid has been shown to accelerate the oxidation of highly unsaturated fatty acids and animal fats low in phenolic inhibitors *(8, 14)*. It may accelerate rancidity in frozen meats *(12)*.

Wood smoke has long been known to protect flesh foods against rancidity as well as against bacterial spoilage. Banks *(3)* found that dehydrated herring were protected for long periods by wood smoke mixed with the air during drying. The heavier the smoking the greater the antioxygenic effect.

Watts and Faulkner *(11)*, in a comparison of the antioxidant effect of commercial liquid smokes, found a wide variation in their retarding action on fat rancidity from no activity at one extreme to a very pronounced antioxidant effect at the other. The protective effect of the smokes studied was at least roughly correlated with phenol content and the smokes containing phenols not only protected fat when used alone but also acted synergistically with ascorbic acid to give a powerful antioxidant combination.

The natural smoking process has a bactericidal as well as an antioxidant effect on flesh foods. Shewan *(9)* demonstrated that chemical constituents of the smoke were responsible for its preservative action on fish; neither the salt used nor the partial drying incident to the smoking process played a significant part in the increased biological stability of smoked fish. Here again phenolic constituents of the wood tar had the highest phenolic coefficients of the various fractions tested. The bactericidal effect of liquid smokes has not been compared.

The characteristic smoke flavor is also associated with fractions of the wood distillate high in phenols *(6)*, although the actual compounds responsible for the flavor have not been identified, nor is it known to what extent the compounds responsible for flavor, antioxidant and bactericidal effects accompany each other in the fractionation and concentration of liquid smoke flavors.

In the present study, the smoke flavor which gave the best results as an antioxidant in artificial systems was tested for its preservative effect on fatty fish which were lightly salted and kept under refrigeration. The smoke was tried alone and also in combination with ascorbic acid. Since it was observed during the course of these experiments that the smoke treated fish did not develop bacterial spoilage as rapidly as controls without the smoke treatment, observations on the bacteriostatic effect of the smoke flavor on several typical organisms were also included.

MATERIALS AND METHODS

Smoke flavor. The commercial smoke preparation* previously found to have the strongest rancidity retarding effect with pork fat *(11)* was chosen for the experiments to be described here. The manufacturers state that this preparation contains in addition to purified fractions of the destructive distillation of wood, oil coriander, oil juniper, iso-eugenol (less than 1% by weight), benzyl alcohol, and propylene glycol. It is free of formaldehyde and contains only a trace of free organic acids. The acute oral toxicity has been tested on albino rats, and the LD_{50}, ml./kg., found to be 6.6 with confidence limits between 5.36 to 8.25.

Source of fish. All the fish were bought on the local market. All those for one experiment were believed to be from the same catch and were fresh in odor and appearance. However, the time of holding could not be definitely ascertained. Spanish mackerel *(Scomberomorus maculatus)* was used for the first experiment, started in February, and striped mullet *(Mugil cephalus)* for a second experiment in October. The fish were transported from the docks at Appalachicola to Tallahassee in ice. They weighed from one half to one pound each.

Preparation for salting. For the first experiment on mackerel the fish were filleted by cutting the flesh from one side of the backbone the length of the fish starting just behind the head, and then cutting a similar strip of flesh from the other side of the backbone. The fillets, of course, did not include any of the abdominal fat. The amount of fat in the fillets varied greatly in different individual fish and in some cases was insufficient for the peroxide determination. Therefore, in the second experiment with mullet, the fish were scaled, headed, cleaned and split along one side of the backbone so that they could be opened out for salting. The position of the cut was such that the layer of fat from the peritoneal lining usually fell on one side of the fish. Because of this distribution of the fat, the lean sides of the mullet were cut off and not used for the experiment. A second cut was made in the flesh along the thick side of the backbone to facilitate penetration of the salt.

* "Imitation Hickory Smoke Flavour" 51.675 A, manufactured by Firmenich, Inc., New York.

Salting and storing. It was desired to preserve the fish by a combination of low salt and refrigeration, rather than by very high concentrations of salt which would need to be removed by soaking before cooking. Preliminary experiments established a salt concentration of 5% of the weight of prepared fish as the upper limit of saltiness for direct consumption (without soaking). This amount is considered too salty by some judges. The amount of smoke and ascorbic acid [b] varied in the two experiments and is reported with the results. The salt, concentrated smoke flavor and ascorbic acid (when used) were mixed thoroughly, then rubbed on the outside of the fish. Immediately after salting the fish were packed in a double layer in enameled pans, pressed down with a weighted pan and stored in a refrigerator at 5° C. (41° F.). Fish from each lot were removed at appropriate intervals, the anterior end used for peroxide determinations and the posterior end was cooked and examined for rancidity or other signs of spoilage.

Extraction of fat and peroxide determination. The fat was extracted by a procedure similar to that previously described for meat *(13)*, i.e. a representative sample of minced tissue was mixed with a drying agent (anhydrous sodium sulphate) and a fat solvent (carbon tetrachloride), whirled in a Waring blendor for 1 minute, then filtered. The proportions finally adopted were 50 g. tissue, 80 g. sodium sulphate and 100 ml. of carbon tetrachloride. Some difficulty was experienced with emulsions and it was occasionally necessary to add more sodium sulphate in order to obtain clear filtrates. As previously stated, some of the fillets tested failed to give sufficient fat for the peroxide determination. If less than 0.4 g. fat was obtained in 20 ml. of filtrate, the sample was discarded.

Aliquots of the filtrate were evaporated to determine the fat content. A quantity of the filtrate containing approximately 0.5 g. fat was then accurately measured and the peroxide value determined by a slight modification of the Wheeler method *(13)*. The results are expressed as milliequivalents of peroxide per 1000 g. fat.

Bacteriostatic effect of smoke flavor. A one to ten dilution of the commercial smoke preparation was made by mixing one part smoke, 5 parts of propylene glycol and 4 parts of water. This 10% solution was further diluted to the concentrations indicated. The pH was adjusted to 6.9, approximately the average for fresh fish. The experiment was carried out by adding one ml. of one-to-ten dilutions of 18-hour fish broth cultures of the test organisms to one ml. of the diluted liquid smoke. The cultures were then incubated at 37° C. (98.6° F.). At various time intervals, ranging from 30 minutes to 48 hours, one loopful of culture was removed and agar slants inoculated in duplicate, using Burri's technique *(1)*. The agar slants were then incubated at 37° C. and inspected after 24 to 48 hours. Controls, consisting of agar slants inoculated with the diluted test organisms without smoke solution, were also incubated under the same conditions.

RESULTS AND DISCUSSION

Experiment I. *The Effect of Smoke Flavor on Mackerel Fillets.* In this experiment fillets treated with salt plus smoke were compared with fillets from the same fish treated with salt alone. The amount of smoke used was 10% of the weight of salt (0.5% of the weight of prepared fish). This concentration of smoke resulted in a very strong smoke flavor unless the fish were soaked before cooking. The results are shown in Table 1.

Great differences were found in rate of fat peroxidation of the individual fish in this and subsequent experiments, especially in the control samples treated with salt alone. Although some of these differences may be associated with accessibility of oxygen to the fat (the fish in the bottom layer being somewhat protected, especially in the early stages of the experiment when partially covered with brine), considerable variability was found in peroxide numbers even of adjoining fish in the same layer. Similar variability in susceptibility of the meat of individual hogs and poultry has been reported *(10)*.

[b] Courtesy Hoffman-La Roche, Nutley, N. J.

TABLE 1

Effect of smoke flavor on keeping qualities of mackerel fillets [1]

Days of storage at 5° C.	Peroxide values				Organoleptic tests	
	Salt Alone		Salt + Smoke [2]		Salt Alone	Salt + Smoke [2]
	Range [3]	Ave.	Range [3]	Ave.		
19	15.8-83	56.5	5.8-8.5	7.3	Off odor and flavor especially in brown lateral line	Good odor
36	55-83	73	5.6-12.0	9.4	Strong stale odor, slight putrefaction. Bacterial colonies	Good odor No putrefaction
47	30-105	77	15.3-25.6	20.8	Heavy bacterial growth. Odor of putrefaction	Good odor No putrefaction

[1] All fillets were rubbed with 5% dry salt.

[2] Firmenich hickory smoke flavor, concentration of 0.5% of weight of fish, mixed with salt. At this concentration the smoke flavor is too strong if fish are cooked directly, but palatable after soaking for 20 minutes in cold water.

[3] Three fish were analyzed in each group.

In spite of these large individual differences, the antioxidant effect of the smoke is very clear. There was no overlapping in the two groups and even at 47 days (the last analysis made) the average peroxide number of the smoke treated samples was much lower than that of the control group at 19 days.

In this and subsequent work, off odors and flavors became noticeable at peroxide values from 35 to 45. These were generally characterized as "stale," "strong" or "fishy" rather than rancid. The end products of the oxidation of the highly unsaturated fatty acids present in fish are undoubtedly different from those obtained from the oxidation of oleic and linoleic acids which predominate in meat animals and the odor does not correspond to that of rancid pork or poultry. The off odor appeared earlier and was generally much stronger in the brown lateral line tissues than in the white meat. The catalytic effect on fat oxidation of the higher concentrations of hemoglobin in the dark tissue is presumably responsible for the earlier development of organoleptic rancidity here. Separate peroxide determinations on white and dark tissue were not made.

The smoke retarded not only rancidity but also bacterial growth. No sign of bacterial spoilage was evident in the smoke treated samples at the end of the experiment, whereas the controls had developed visible bacterial colonies (white and pink spots) and a slight putrefactive odor after 36 days of storage.

Experiment II. *The Effect of Ascorbic Acid with Low Concentrations of Smoke on Salted Mullet.* This experiment was carried out at a time of year when mackerel were not available locally; therefore another fatty fish, mullet, was used instead. As explained under methods, these fish were split rather than filleted in order to retain the peritoneal fat. The amount of salt used (5%) was the same as in the previous experiment. The smoke was reduced to one fifth of the previous level (0.1% of the weight of the fish). At this concentration the cooked fish had a desirable mild smoke flavor without previous soaking. The ascorbic acid, smoke and salt

were mixed thoroughly before application to the fish. Four experimental variations were required for proper interpretation of the results; i.e. (a) a control with salt alone, (b) salt with ascorbic acid, (c) salt with smoke and (d) salt, smoke, and ascorbic acid combined.

The pH of the brines from the 4 experimental variations was measured after one and 5 days. As might be expected, ascorbic acid caused a marked initial lowering of the pH, which increased slightly after 5 days of storage. As will be seen in Table 2, the darkening of the brine, probably due to the formation of melanin pigments, was retarded by the ascorbic acid during the first 24 hours, but after 5 days all the brines looked much alike.

TABLE 2
Appearance and pH of brines forming on mullet

Treatment	pH		Appearance of brine	
	1 day	5 days	1 day	5 days
I Salt only	6.50	6.38	dark reddish brown	dark
II Salt + ascorbic	5.92	6.13	light	dark
III Salt + smoke	6.55	6.40	slightly discolored	dark
IV Salt + smoke + ascorbic	5.80	6.02	very light	dark

Peroxide values at various time intervals are shown in Table 3. The rate of peroxide formation of the controls was more rapid in this experiment than in the previous experiment with mackerel. Ascorbic acid alone provided no protection. The reduced amount of smoke was still effective as an antioxidant. The combination of reduced smoke with ascorbic acid was extremely effective.

TABLE 3
Effect of ascorbic acid and smoke flavor on peroxide formation in mullet [1]

Treatment [2]	Peroxide values					
	10 days		20 days		34 days	
	Range [3]	Ave.	Range [3]	Ave.	Range [3]	Ave.
I Control (salt only)	30-142	83	90-202	156	....	....
II Ascorbic acid 0.1%	32-163	90	78-166	119	....	....
III Liquid smoke 0.1%	7.4-27	16.5	26-60	45	....	....
IV Ascorbic acid + smoke	0	0	0-19	5	2.7-20	11.4

[1] All mullet were rubbed with 5% dry salt and refrigerated at 5° C.
[2] Amounts specified based on weight of fish.
[3] Four fish were analyzed in each group.

Signs of bacterial spoilage became evident in the control and ascorbic acid treated samples between the tenth and twentieth days. At 20 days both samples had a slight odor of putrefaction and some surface sliminess in addition to a strong "stale fish" odor probably associated with fat oxidation. At 34 days bacterial decomposition was far advanced. The lowered pH caused by the ascorbic acid did not delay the onset of bacterial spoilage. However, in both samples containing the liquid smoke bacterial spoilage was delayed, and the combination of smoke and ascorbic acid seemed to inhibit more than the smoke alone. Possibly the bacteriostatic agents in the liquid smoke are more effective at a low pH. At the last test period (34 days) all samples were showing incipient spoilage, but this was less advanced in the lot treated with both ascorbic acid and smoke. At this time the "stale fish" odor was marked in the fish treated with liquid smoke alone.

Irregular darkening of the flesh occurred in all 4 lots of fish and did not seem to be influenced by any of the treatments. The cause of this darkening, which made the fish unattractive in appearance, is not known. The so-called "black skin," i.e. the heavily pigmented layer on the inner surface of the peritoneal cavity, was not removed and may have contributed to this discoloration.

Experiment III. *The Effect of Liquid Smoke on Bacterial Growth.* Because of the effectiveness of the liquid smoke in retarding signs of bacterial spoilage in fish in the preceding experiments, a third experiment was performed to test the effect of several concentrations of the liquid smoke on pure cultures of the test organisms *Staphylococcus aureus, Bacillus subtilis,* and *Proteus vulgaris.* A commonly used technique for testing preservatives was used in which pure cultures of the representative test organisms were added to appropriate dilutions of the smoke flavor. After various incubation periods, agar slants were inoculated from the cultured smokes, incubated and inspected after 24 and 48 hours for bacterial growth. The detailed procedure is described under methods.

The results of a typical experiment of this kind are shown in Table 4. At a smoke concentration of 0.8% all test organisms were completely inhibited after various times ranging from less than 30 minutes in the case of *B. subtilis* to more than 6 hours for *S. aureus.* At a tenfold greater dilution the smoke did not completely inhibit any of the organisms but reduced growth in all of them. In another experiment, at a concentration of 0.4% inhibition of all test organisms was obtained in less than 22 hours, but .04% smoke gave no inhibition.

TABLE 4
Effect of 0.8 and 0.08% smoke flavor on growth [1] of different micro-organisms

Time in contact with smoke	Growth response of test organisms [2, 3]					
	S. aureus		*P. vulgaris*		*B. subtilis*	
	0.8%	0.08%	0.8%	0.08%	0.8%	0.08%
30 min.	++	++	++	++	−	+++
1 hour	++	++	+	++	−	+++
4 hours	+	++	−	+	0	+++
6 hours	+	++	−	+	0	++
22 hours	−	+	0	±	0	++
24 hours	−	+	0	+	0	++
48 hours	0	+	0	+	0	++

[1] + = slight growth
++ = pronounced
+++ = heavy growth
− = no growth
0 = not done
[2] After 24 hours incubation. The results were identical after 48 hours incubation.
[3] All controls showed heavy growth.

The actual concentration of smoke at the surface of the fish in the preceding experiments is difficult to estimate. When amounts of liquid smoke in the range of 0.1 to 0.5% of the total weight of fish are applied to the outside, the initial contact concentration might be expected to be considerably higher than this. On the other hand, with the method of application described, distribution of the smoke on the surface is probably nonuniform and solution may be slow. No information is available on the rate of penetration of the smoke ingredients into the fish.

SUMMARY

Rancidity, as determined by peroxide numbers of extracted fat, and bacterial spoilage (putrefactive odors and sliminess) were followed in refrigerated mackerel and mullet treated with 5% salt with or without the addition of a liquid smoke and/ or ascorbic acid.

High concentrations (0.5%) of the liquid smoke gave excellent protection against both rancidity and bacterial spoilage. However, this treatment produced too strong a smoke flavor and would be uneconomical. A smoke concentration of 0.1% still had considerable preservative action and a mild smoke flavor.

Ascorbic acid, when mixed with the salt at a concentration of 0.1% of the weight of fish, did not protect against rancidity. However, the ascorbic acid acted synergistically with small concentrations of smoke to give a powerful antioxidant combination.

The liquid smoke at concentrations of 0.4 and 0.8%, proved toxic to cultures of *Staphylococcus aureus*, *Bacillus subtilis* and *Proteus vulgaris* after various exposure times. Smoke concentrations of 0.08% decreased but did not stop growth of the test organisms.

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Variance in Chemical Determinations of Added Moisture

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The generally used chemical method of determining added moisture in sausage was applied by three laboratories in analyses on 25 samples of bologna to determine the magnitude and sources of differences in results.

The chemical method used in determining the added moisture in sausage products involves finding the moisture and protein content of samples and substituting these values in the equation: added moisture = moisture, percent — 4 x protein, percent. This determination has been applied in the laboratories of the Meat Inspection Service with a high degree of accuracy.[c] Informal statements have been received indicating that results obtained in other laboratories failed to closely agree with those of the Meat Inspection Service and led to an investigation at Beltsville of the magnitude of the differences to be expected between the results from different laboratories in the determination of the added moisture content of bologna. Data were obtained reflecting variations which may occur in applying the method, including those produced in both sampling and analysis. In this work 25 batches of bologna were prepared from carefully controlled quantities of ingredients with the assistance of a commercial sausage technician. Samples from each batch were analyzed by each of three laboratories. The analytical data obtained in these analyses have been summarized and statistically analyzed and are presented and discussed here.

PREPARATION, SAMPLING AND ANALYSIS OF BOLOGNA

Five series each consisting of 5 approximately 60-pound batches of bologna were produced in small commercial-sized equipment. Technical assistance was provided by the Eastern Meat Packers Association, Inc. Information on the composition and processing of these bolognas is given in Table 1.

A bologna from each of the 25 batches was divided into samples as follows: Each bologna was cut along its long axis into halves and then into sixths; these were cut across their center at right angles to their long axis to provide 12 sections of

[a] Deceased.

[b] The authors wish to acknowledge the assistance of R. H. Philbeck and W. R. Kauffman of the Meat Inspection Service and Animal and Poultry Husbandry Research, respectively, of the Agriciultural Research Service, and the Eastern Meat Packers Association, Inc. in obtaining the analyses reported, and to Harry S. Sloane of the Animal Husbandry Division for statistical analyses of the data.

[c] Private communication.

approximately equal size and of similar form. Two sections from opposite ends and diametrically opposite locations were selected for each sample. Samples were analyzed by A.O.A.C. methods 22.3 and 2.24[a] to determine their moisture and protein content at the laboratories of the Animal Husbandry Division and the Meat Inspection Division of the Bureau of Animal Industry and by an independent chemist.[c] The results of the analyses and the added moisture values which were calculated are shown in Table 2.

To obtain data on samples of maximum homogeneity, 5 other batches of bologna were finely ground and thoroughly mixed. Samples were withdrawn and distributed to the three analytical laboratories who performed analyses with the results shown in Table 3.

STATISTICAL ANALYSES AND DISCUSSION OF THE DATA

The most reliable index of the added moisture in the 25 bolognas was assumed to be the mean (average) of the estimates supplied by the three laboratories. Deviation from these mean values was used as a measure of variation in the estimates. The data were subjected to an analysis of variance. No significant difference was found between the data supplied by one laboratory and that of another in the analyses reported in Tables 1 and 2. The standard deviation of the determinations of added moisture was computed to be $\pm 1.40\%$, i.e., a laboratory's estimate was within $\pm 1.40\%$ (absolute) of the mean of values obtained by the three laboratories in 68% of the analyses and more than $\pm 1.40\%$ in the remaining 32%. Moisture and protein determinations contributed 24 and 76% respectively to the total variance of added moisture values.

The standard deviation of the determinations made on the 5 homogeneous samples (Table 3) was $\pm 1.47\%$; however, in this case one laboratory (H) obtained significantly different results from the other two. The standard deviation of the determinations of the two laboratories in closest agreement was $\pm 0.7\%$. The standard deviation of the results of these same two laboratories in analyzing the 25 bolognas was $\pm 1.07\%$. A comparison of this value with the standard deviation of $\pm 0.7\%$ obtained by the same laboratories in analyses of homogeneous samples indicates that the largest proportion of variance in the analyses on bologna was in the determinations per se, although the effect of variations in samples was appreciable.

Owing to the magnitude of variation attributable to sampling, investigation aimed at developing improved sampling methods is recommended, undertaken with attention to amounts required and timing, as well as other details of the procedure.

As might be expected in view of the effect of several factors, including the different degrees to which meat emulsion of varying moisture content loses moisture in processing, the actual proportion of moisture added to

[a] Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists, 7th Ed., 1950, variations in drying methods being that the laboratory hereinafter designated as M dried at room atmosphere by an official modification described in the February, 1953 issue of the Journal and laboratory A followed the procedures described under section 22.3, except that samples were dried one hour without vacuum at 98-100° C. followed by 4 hours of vacuum drying.

[c] Chemist whose services were obtained by the Eastern Meat Packers' Association, Inc.

TABLE 1

Composition and processing data on bologna prepared in five series of experiments

Series	Sample number	Meat[1]			Ice	Chopping[2]		Spices	Composition of finished product[3]				
		Beef	Lean pork	Fat pork		Time	Temperature at completion		Moisture	Fat	Protein	Added moisture	Caloric content[4]
		%	%	%	*lb.*	*min.*	*° F.*	*g.*	%	%	%	%	*Cal./100 g.*
I	3-20-1	49.7	25.15	25.15	5.0	5.8	57	82	57.2	24.2	13.8	2.0	307
	3-20-2	50.0	25.0	25.0	9.0	10.0	57	88	59.0	23.6	12.9	7.4	297
	3-20-3	49.0	25.5	25.5	11.0	11.3	57	91	60.5	22.6	12.6	10.1	286
	3-20-4	50.2	24.9	24.9	15.0	12.5	57	97	62.0	21.8	11.8	14.8	274
	3-20-5	49.5	25.25	25.25	22.5	19.0	57	108	65.8	19.2	11.3	20.6	245
II	4-21-1	50.0	25.0	25.0	7.5	7.5	56	86	59.1	24.1	13.6	4.7	306
	4-21-2	50.0	25.0	25.0	11.0	10.0	56	91	61.8	21.6	13.6	7.4	282
	4-21-3	50.0	25.0	25.0	15.0	17.5	56	97	62.5	21.6	13.1	10.1	279
	4-21-4	50.0	25.0	25.0	7.5	10.0	65	86	59.0	23.7	14.0	3.0	304
	4-21-5	50.0	25.0	25.0	15.0	10.0	40	97	63.1	21.3	12.9	11.5	275
III	5-5-1	50.0	37.5	12.50	11.0	10.0	56	112	66.7	13.7	15.7	3.9	219
	5-5-2	50.0	31.25	18.75	11.0	10.0	56	112	63.9	17.4	14.4	6.3	246
	5-5-3	50.0	25.00	25.00	11.0	10.0	56	112	61.2	21.1	13.9	5.6	279
	5-5-4	50.0	18.75	31.25	11.0	10.0	56	112	57.9	26.3	12.4	8.3	319
	5-5-5	50.0	12.50	37.50	11.0	10.0	56	112	55.7	30.1	11.5	9.7	350
IV	7-14-1	50.0	20.0	30.0	7.5	7.0	57	92	58.0	25.9	12.8	6.8	318
	7-14-2	50.0	20.0	30.0	10.0	11.0	57	97	59.6	24.2	12.4	10.0	300
	7-14-3	50.0	20.0	30.0	15.0	12.0	57	105	61.3	24.2	11.3	16.1	292
	7-14-4	50.0	20.0	30.0	18.0	21.0	57	110	63.3	23.0	11.2	18.5	282
	7-14-5	50.0	20.0	30.0	22.0	18.0	57	116	65.2	21.4	10.5	23.2	262
V	7-30-1	50.0	31.25	18.75	15.0	11.0	57	100	65.9	17.9	13.6	11.5	247
	7-30-2	50.0	25.0	25.0	15.0	12.5	57	100	63.4	20.6	12.8	12.2	267
	7-30-3	50.0	18.75	31.25	15.0	11.5	57	100	60.4	25.2	11.7	13.6	305
	7-30-4	50.0	12.50	37.50	15.0	10.0	57	100	56.3	29.9	10.7	13.5	344
	7-30-5	50.0	6.25	43.75	15.0	11.5	57	100	52.3	34.8	10.3	11.1	388

[1] Each batch of meat weighed a total of 50 pounds.

[2] Other processing of Series I, IV and V included smoking approximately 5½ hours and cooking approximately 1½ hours. Series II and III were not cooked but smoked 7 hours. All reached a maximum internal temperature of *ca.* 150-152° F.

[3] Based on averages of analyses supplied by 3 laboratories.

[4] Caloric content calculated on the basis of protein and fat being equivalent to 5.65 and 9.5 large calories per g.

TABLE 2

Analyses of 25 bolognas by three laboratories [1]

Series	Sample number	Moisture %			Protein %			Added moisture %[2]			
		A	M	H	A	M	H	A	M	H	Mean
I	1	57.6	57.1	56.8	13.8	13.8	13.7	2.4	1.9	2.0	2.1
	2	59.0	59.4	58.7	12.9	12.7	13.0	7.4	8.6	6.7	7.6
	3	60.7	60.7	60.3	12.8	12.7	12.5	9.5	9.9	10.3	9.9
	4	62.5	62.1	61.5	11.7	11.8	11.9	15.7	14.9	13.9	14.8
	5	65.9	65.7	66.0	11.3	11.5	11.0	20.7	19.7	22.0	20.8
II	1	58.9	58.5	60.0	13.8	13.8	13.3	3.7	3.3	6.8	4.6
	2	61.4	61.6	62.5	13.7	13.7	13.4	6.6	6.8	8.9	7.4
	3	62.4	62.2	63.0	12.8	13.3	13.1	11.2	9.0	10.6	10.3
	4	58.8	59.2	67.4[3]	14.0	13.9	12.6[3]	2.8	3.6	3.2[4]	3.2
	5	62.4	62.8	64.0	13.1	12.9	12.7	10.0	11.2	13.2	11.5
III	1	66.7	67.2	66.3	15.7	15.8	15.5	3.9	4.0	4.3	4.1
	2	64.0	64.6	63.2	14.6	14.6	14.2	5.6	6.2	6.4	6.1
	3	61.5	61.0	61.1	13.8	14.1	13.9	6.3	4.6	5.5	5.5
	4	57.6	58.2	57.8	12.6	12.4	12.2	7.2	8.6	9.0	8.3
	5	55.6	55.9	55.8	11.5	11.8	11.2	9.6	8.7	11.0	9.8
IV	1	57.8	59.4	56.9	12.7	12.9	12.8	7.0	7.8	5.7	6.8
	2	59.9	60.1	58.8	12.4	12.5	12.1	10.3	10.1	10.4	10.3
	3	61.8	63.0	59.2	11.2	11.4	11.4	17.0	17.4	13.6	16.0
	4	63.7	63.4	62.8	10.9	11.6	11.0	20.1	17.0	18.8	18.6
	5	66.2	66.3	63.3	10.1	10.6	10.9	25.8	23.8	19.7	23.1
V	1	65.7	65.4	65.6	13.6	13.4	13.9	11.3	11.8	10.0	11.0
	2	64.3	62.2	63.7	12.4	12.9	13.0	14.7	10.6	11.7	12.3
	3	60.4	60.8	60.0	11.5	11.6	12.0	14.4	14.4	12.0	13.6
	4	56.7	55.2	57.0	11.4	10.8	11.0	11.1	12.0	13.0	12.0
	5	52.4	50.9	53.5	10.1	10.6	10.1	12.0	8.5	13.1	11.2

[1] The laboratories of Animal and Poultry Husbandry Research, Meat Inspection Service and the commercial analytical chemist are designated A, M and H, respectively.

[2] The standard deviation of the added moisture computed by statistical analysis was ±1.40%.

[3] Values discarded.

[4] Calculated from A and M results.

TABLE 3

Analyses of five homogeneous samples of bologna by three laboratories [1]

Sample number	Moisture %			Protein %			Added moisture %[2]			
	A	M	H	A	M	H	A	M	H	Mean
9-11-1	54.7	55.2	55.1	14.8	14.5	14.4	—4.5	—2.8	—2.5	—3.3
9-11-2	58.9	58.9	58.9	13.4	13.3	12.9	5.3	5.7	7.3	6.1
9-11-3	60.8	61.1	60.7	13.6	13.7	12.5	6.4	6.3	10.7	7.8
9-11-4	60.5	60.8	61.1	12.5	12.3	11.4	10.5	11.6	15.5	12.5
9-11-5	62.7	62.8	63.1	11.6	11.6	10.7	16.3	16.4	20.3	17.7

[1] The laboratories of Animal and Poultry Husbandry Research, Meat Inspection Service and the commercial analytical chemist are designated A, M and H, respectively.

[2] The standard deviation of the added moisture determined by the three laboratories computed by statistical analysis was ±1.47%; by the two laboratories in closest agreement, ±0.7%.

the meat (Table 1) was not indicated, even approximately, by the percentage of added moisture in the finished product. Also, the chemically determined added moisture content was not necessarily closely related to the protein content, the most important index of the food value of meat. The present data show, for example, that samples 4 and 5 of Series III and V had low contents of added moisture and low contents of protein, rather than high, as might be expected if one used the added moisture as the only criterion. In these samples a high content of fat rather than a high content of moisture was associated with low protein content. An appreciable variation in chemically determined added moisture occurred in the samples in Series III and V although each of the series was prepared using the same proportion of added ice. These are limitations which exist in using the added moisture determination as a basis for judging the materials used in the preparation of bologna and the nutritional quality of the product and serve to emphasize the desirability of developing an improved method of judging quality. It appears possible that content of meat protein would be sufficiently informative.

SUMMARY

In analyses of 25 samples of bologna by three laboratories, the standard deviation of the determination of the percentage of added moisture in bologna was ±1.40% (absolute).

Owing to several factors, including the effect of different proportions of fat and moisture on losses of moisture during processing, the percentage of added moisture in the bologna was not a consistently dependable index of the moisture used in preparation of the product. Since fat in some samples replaced both moisture and protein, a low content of added moisture did not indicate high nutritional quality in relation to protein.

Owing to the magnitude of variation attributable to sampling, investigation aimed at developing improved methods is recommended.

Use of the 2-Thiobarbituric Acid Reagent to Measure Rancidity in Frozen Pork

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A method is given for the use of 2-thiobarbituric acid (TBA) reagent to determine rancidity in frozen pork. The reproducibility of the method and the influence of various factors such as the presence of carbohydrates, time of heating with TBA and meat particle size are discussed.

When held in freezer storage, pork frequently develops off-flavors which are recognized in the meat industry as a "freezer taste." Since "freezer taste" is associated with the development of incipient rancidity, "oxidized flavor" would be a more appropriate term. The chemical tests ordinarily used to measure oxidative rancidity are not sensitive enough to detect these early changes. The Schibsted aldehyde test *(11)* and the quantitative Kreis test *(15)* lack sufficient sensitivity *(14)*. Peroxide values give a measure of intermediate breakdown products and the peroxide value may vary considerably at the organoleptic threshold for rancidity. Naumann, Brady, Palmer, and Tucker *(8)* found a tendency for individual hog carcasses to be predisposed to individual levels of peroxide for any given degree of flavor or odor.

The oxidation of animal tissues and certain lipids produces compound(s) which will condense with 2-thiobarbituric acid (TBA) to give an orange-red color *(1, 2, 7, 16)*. Patton and Kurtz *(9)* found malonic dialdehyde gave a red color when heated with TBA and spectral analysis of this color revealed it to be identical with the color obtained similarly from oxidized milk fat and to closely resemble the colors obtained with oxidized animal tissues. Sidwell, Salwin, Benca, and Mitchell *(12)* found that glyoxal and chloral hydrate gave a red color but that most other aldehydes resulted in a yellow to brown color. They think carbonyl groups may be responsible for the chromophore development observed with rancid fats but a high TBA value is sometimes obtained with samples having a low carbonyl value.

Dunkley *(5, 6)* obtained a very good correlation between TBA values and oxidized flavor in milk. Patton and Kurtz *(9)* used the TBA test to measure oxidized flavor in milk and concluded that this test was more sensitive than conventional tests such as iodine value and Kreis test. Biggs and Bryant *(3)* modified the TBA test to detect oxidative rancidity in butter, Cheddar cheese, and powdered whole milk. Sidwell, Salwin, and Mitchell *(13)* applied the TBA test to dried milk products. Sidwell *et al.* used steam distillation to separate the products of fat oxidation from dried milk products preparatory to reaction with 2-thiobarbituric acid in order to avoid interference from the lactose and protein constituents. Their results correlated well with sensory evaluations.

This paper describes the use of TBA reagent to measure oxidative rancidity in frozen pork.

METHODS

Preparation of ground pork and wieners for taste test analysis. Samples of ground pork were prepared for taste test evaluation by blending varying amounts of fresh regular pork with representative lots of commercially frozen regular pork trimmings. Three lots of frozen pork with initial TBA values of 0.575, 0.490 and 0.214, which were 12 mo. —20 days, 13 mo., and 6 mo. old, respectively, were used for this study. Four batches were made from each lot of frozen pork by blending the defrosted trimmings with 0, 25, 50, and 100% fresh regular pork. A moderate level of pork sausage spice was mixed with the blended samples; they were then stuffed into one-lb. cellophane tubes and stored at 0° to 5° F. (—17.8° to —15° C.) during the entire 2-week testing period for each lot.

Skinless wieners were manufactured from the above lots of frozen pork plus a sample of 17 mo. old frozen pork which had an initial TBA value of 0.758 using 0, 15, 30, and 60% frozen pork chopped with fresh regular pork and fresh cow meat to give a final meat formula of 60% regular pork and 40% cow meat. The wiener batter was chopped under carefully controlled conditions, stuffed into $^{28}/_{32}$ in. Visking casing, smoked 2½ hours, and cooked to an internal temperature of 155° F. (68.3° C.).

The wieners were packed in 10-lb. cartons and stored at 33° to 35° F. (0.6° to 1.7° C.) during the entire 10-day testing period for each lot.

Procedure used for taste test analysis. The pork patties and wiener samples were taste tested after 1, 6, 10 and 14 days of storage by a panel of 25 experienced taste testers. Four coded samples (one control and 3 samples containing varying levels of frozen pork) were distributed at each taste test. The samples were judged as either *acceptable, borderline,* or *not acceptable* according to their level of rancid flavor. A numerical score of 1 was assigned to the acceptable samples, 2 to the borderline, and 3 for not acceptable. The taste test results were statistically analyzed to determine the level of significant difference between the samples tested. Correlation studies between TBA values of the meat used and taste test acceptability scores were calculated by the Cureton and Dunlap method using their C-D Hand Correlation Chart *(4)*.

2-Thiobarbituric acid (TBA) test for rancidity. Samples were prepared for TBA analysis by grinding twice through a ⅛-in. plate followed by thorough mixing after each grinding operation to ensure a uniform mixture. The ground samples were stored at 32° F. (0° C.) to prevent further changes prior to analysis.

The TBA test was carried out as follows: Place 5 g. meat, 5 ml. 20% trichloroacetic acid in 2 M phosphoric acid, and 10 ml. of 0.01 M 2-thiobarbituric acid (Eastman Kodak) in a 50 ml. centrifuge tube. Heat in a boiling water bath for 30 min. with occasional stirring, then chill the tubes in an ice bath for 10 min. Remove the solid fat layer with a spatula; the pink colored TBA complex is located in the aqueous layer. Add 15 ml. of solvent containing a mixture of 2:1 iso-amyl alcohol-pyridine. Shake the tubes vigorously for 2 min. then centrifuge for 15 min. at 2400 r.p.m. to break the emulsion formed during the extraction. Decant the clear solvent extract into a cuvet and measure the color at 538 mμ against a solvent blank. The TBA value is defined as absorbency at 538 mμ using a Beckman DU spectrophotometer and standard size one cm. corex cuvets.

A 0.01 M aqueous solution of 2-thiobarbituric acid was added to the reaction mixture just prior to heating because the TBA reagent is only slightly soluble in acid solution and precipitates after standing a short time at room temperature. The aldehydes or carbonyl compounds responsible for the TBA color may exist in some loose combination with the meat protein because the addition of 5 ml. 2 M phosphoric was necessary for maximum color development. The use of trichloroacetic acid in the test mixture prevents turbidity in the solvent extract and eliminates the presence of red color in the solid fat layer so the fat layer can be removed prior to solvent extraction. A more complete and more uniform extraction of the TBA color was obtained with a 2:1 isoamyl alcohol-pyridine solution than with isoamyl alcohol alone.

Determination of fat peroxides. Peroxide numbers (m.e. peroxide/kg. fat) were determined using the procedure described by Rockwood, Ramsbottom and Mehlenbacher *(10)*.

RESULTS AND DISCUSSION

Frozen pork reacts with the TBA reagent to give a bright pink color and the solvent extract exhibits an absorption maximum at 535-538 mμ which is approximately the same as Patton and Kurtz *(9)* observed with oxidized milk fat or malonic dialdehyde. This color is presumably due to the presence of a 3-carbon aldehyde formed by the oxidation of unsaturated fatty acids *(2)*.

The effect of time of heating with TBA reagent. Fresh pork gives some color when heated with TBA and the amount of color increases with the time of heating. Figure 1 shows the increase in TBA value observed with increased time of heating. The test was standardized using a 30 min. heating period partly as a matter of convenience (30 min. allows the analyst ample time to prepare another set of tubes for analysis) and also gives a good differentiation between fresh and rancid samples.

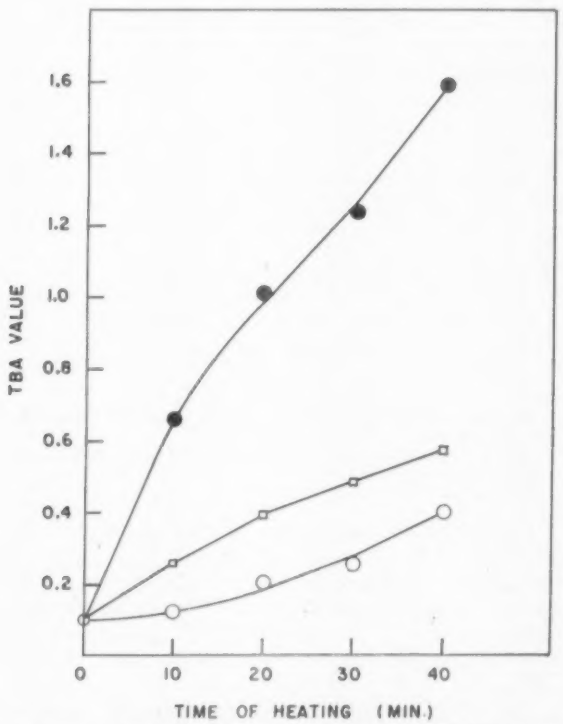

Figure 1. The effect of time of heating with TBA reagent at 100° C. on the amount of color produced.
○ = fresh pork.
□ = very slightly rancid pork.
● = very rancid pork.

When the tubes are heated 30 min. in a boiling water bath and then chilled immediately, they may be held for as long as 1 hr. without a significant increase in TBA value. However, a 10 to 20% increase is observed when the tubes are held 24 hr. at 4° C.

Extraction with iso-amyl alcohol-pyridine solution. A uniform extraction of the TBA complex is achieved by 2 min. vigorous shaking with iso-amyl alcohol-pyridine solution and this procedure was found to be satisfactory for routine analysis. However, the distribution coefficient is less than 1.0 and if one desires a quantitative separation with very rancid samples, it is necessary to make several extractions using fresh solvent. The colored complex is fairly stable and the solvent extract can be held several hours without appreciable change.

The effect of meat particle size on the TBA test. The degree of comminution and the uniformity of meat particle size is of critical importance in establishing a standardized procedure. Table 1 shows the effect of meat particle size on the TBA value obtained with one sample of rancid pork.

TABLE 1
The effect of meat particle size on the TBA value

Degree of comminution	TBA value
Coarse grind (one pass through 3/8-in. plate)	0.748
Standard procedure (two passes through 1/8-in. plate)	0.990
Complete disintegration	1.200

Reproducible results were obtained when the samples were ground twice through a 1/8-in. plate; since most laboratories use a meat grinder for sample preparation, the test was standardized using this procedure. Several TBA analyses were carried out on a single sample of pork to determine the reliability of this technique. The TBA values obtained on the test sample were as follows: 0.437; 0.451; 0.439; 0.441; 0.444; 0.460; 0.444; 0.452. The average is 0.446.

The standard deviation from the mean is 0.008. The standard error of the mean is 0.003. The 99% confidence limits for the true mean of this sample are 0.436 to 0.456. These limits are well within the accuracy necessary to correlate with taste test analyses.

The effect of carbohydrates on the TBA test for rancidity. Wilbur, Bernheim, and Shapiro *(16)* studied the reaction of certain sugars with TBA and found fructose produced the most color while sucrose gave somewhat less color than the sum of its constituent sugars. The small amounts of naturally occurring carbohydrates present in fresh beef or pork tissue do not interfere with the TBA test. However, the sugars present in cured meats and sausage products may offer a serious limitation to the test unless some correction is made for their presence. Tests were carried out to determine the effect of added sucrose, glucose, or soluble starch on the TBA test with frozen pork (Table 2). The addition of 1% glucose or soluble starch had no appreciable effect. However, the addition of 1% sucrose resulted in a 71% increase in TBA value.

TABLE 2
The effect of carbohydrates on the TBA test for rancidity

Sample	TBA value
Frozen pork	0.266
50 mg. glucose	0.025
50 mg. sucrose	0.270
5 g. frozen pork + 50 mg. glucose	0.264
5 g. frozen pork + 50 mg. sucrose	0.456
5 g. frozen pork + 50 mg. soluble starch	0.261
5 g. frozen pork + 10 mg. glucose + 10 mg. sucrose equivalent to approximately 0.2% of each sugar.	0.296

Allowance can be made for the presence of sugar in cured meats and sausage products by using a fresh control containing the correct amount of sugar as an internal standard. The method suggested by Sidwell, Salwin, and Mitchell *(13)*, where steam distillation is used to separate the products of fat oxidation free from the other constituents, might work satisfactorily for cured meats. However, our studies show that wood smoke contains compounds which react with TBA to give a red color, and these compounds are very likely to be volatilized by steam distillation so the outer surface of wieners or other smoked meats should be removed prior to testing.

The chief value of the TBA test to the meat packer is that it offers a rapid yet sensitive method for grading frozen pork prior to its use in manufactured products. The TBA values reported in this paper were obtained on raw pork before it was manufactured into wieners and pork patties.

Correlation between the TBA test and peroxide number. The TBA test is a much more sensitive measure of incipient rancidity or "freezer taste" than the chemical test for fat peroxides. Earlier studies at this laboratory showed very little correlation between peroxide values and the rancidity of frozen pork. Peroxides are intermediates in the oxidation of fats, and they can vary considerably as the oxidation proceeds. The TBA test takes advantage of a color reaction between TBA and aldehydes which are believed to be the flavor compounds responsible for oxidative rancidity.

A comparison between the TBA values and the peroxide numbers obtained for several samples of frozen pork ranging from 4 to 17 months old are given in Table 3. The TBA values increase with the age of sample,

TABLE 3
Correlation between TBA values and peroxide numbers of frozen regular pork

Age of sample[1]	TBA value	Peroxide number[2]
4 months	0.224	0.24
10 months	0.277	0.37
11 months	0.274	0.54
13 months	0.335	0.37
14 months	0.342	0.86
15 months	0.350	0.44
16 months	0.438	0.53
17 months	0.443	0.57

[1] These determinations were carried out immediately after defrosting the frozen meat to a temperature of 35° F.
[2] Peroxide number = m.e. peroxide/kg. fat.

whereas the peroxide numbers show considerable variation. At first glance there appears to be a greater spread between the peroxide numbers, but these were calculated from titrations of only 0.1 to 0.44 ml. of 0.01 N sodium thiosulfate and are much less reliable than the TBA values.

The organoleptic level of rancidity is usually considered to be 20 m.e. peroxide/kg. of fat. Results obtained at this laboratory indicate that rancid pork can be extremely unpalatable at much lower peroxide values.

Naumann *et al. (8)* observed much higher peroxide values (13 to 32 m.e./kg. fat) for 12 month old frozen pork. This difference is attributed to the fact that they ground the pork prior to freezer storage and stored the meat under less ideal conditions.

Correlation between TBA values and taste test scores for ground pork. Samples of ground pork, which had been prepared and packaged as described earlier, were analyzed by the TBA test and served as broiled pork patties for taste test evaluation after 1, 6, 10 and 14 days of storage at 0° to 5° F. (—17.8° to —15° C.). A highly significant positive correlation of 0.74 was obtained between the TBA values and palatability scores (Figure 2). Pork with a TBA value above 0.46 was judged to be of borderline quality and pork with a TBA value over 1.2 was found unacceptable by the taste test panel.

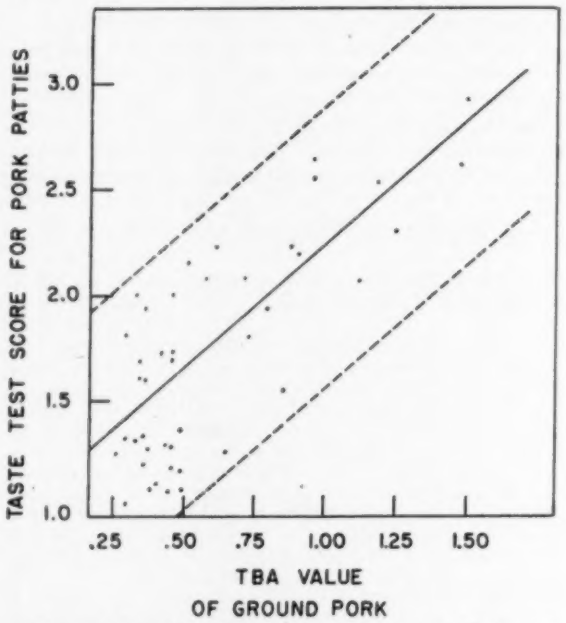

Figure 2. Correlation between the TBA test and taste test for pork patties.
Taste test scores 1.0-1.5, acceptable; 1.5-2.5, borderline; 2.5-3.0, not acceptable.
Correlation = .74.

Figure 3 shows the effect of 10 days' storage at 0° to 5° F. (—17.8° to —15° C.) on the TBA value of ground pork packaged in 1-lb. cellophane tubes. Pork with an initial TBA value over 0.42 deteriorated to borderline quality and when the initial TBA value was over 0.93 the sample became unacceptable after 10 days storage.

The TBA test offers an effective laboratory tool for determining the presence of incipient rancidity in frozen pork.

Correlation between the TBA value of pork used and taste test acceptability scores for wieners.

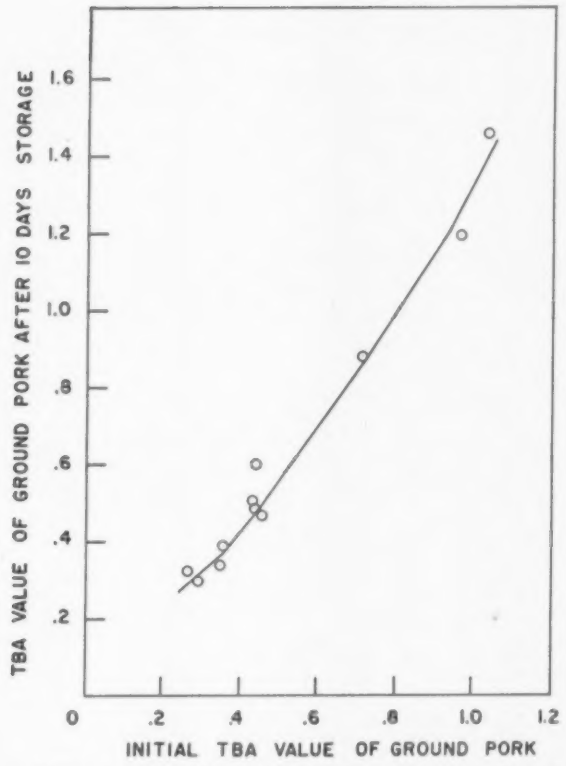

Figure 3. Increase in the TBA value of ground pork stored 10 days at 0° to 5° F (—17.8° to —15° C.).

A significant positive correlation of 0.66 was obtained between the TBA value of the pork used in manufacturing the wieners (TBA value of fresh pork × percent fresh pork + TBA value of frozen pork × percent frozen pork) and the taste test acceptability scores obtained over the 10-day testing period (Figure 4). The higher the TBA value of pork used the greater the danger of obtaining a borderline or unacceptable product. Because of numerous factors involved in the manufacture of a product such as wieners, it is difficult to assign absolute limits for acceptable TBA values. However, it can be concluded from observations made with wieners manufactured from 60% regular pork and 40% cow meat that the following limits are conservative and workable: Pork having a TBA value below 0.30 will produce an acceptable wiener and pork with a TBA value of 0.55 or over will result in an unacceptable product. The TBA test is very useful for predicting the quality of wiener or other sausage product that can be manufactured from a given sample of frozen pork.

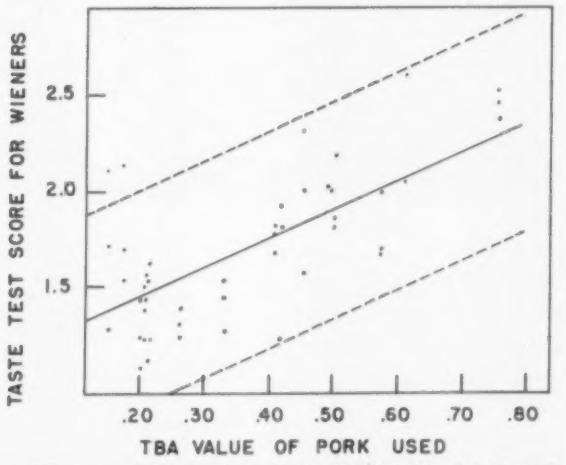

Figure 4. Correlation between the TBA value of pork used and taste test scores for wieners.
Taste test scores 1.0-1.5, acceptable; 1.5-2.5, borderline; and 2.5-3.0, not acceptable.
Correlation = .66.

SUMMARY

The TBA test gives a more reliable index of the age and quality of frozen pork than other chemical tests for fat rancidity. A significant positive correlation was obtained between taste test acceptability scores for wieners and pork patties and the TBA value of pork used.

The TBA test should be a very useful laboratory tool for studying the effect of storage and processing conditions on the development of oxidative rancidity in regular pork and offers a new method for grading the quality of meat to be used in the manufacture of sausage products.

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Consistency Measurements of Tomato Puree[a,b]

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Consistency of tomato puree (pulp) manufactured under pilot plant conditions was measured by using the Bostwick Consistometer, Adams Consistometer, Stormer Viscosimeter, Efflux-Tube Viscometer and the Blotter Test. Correlations and data are presented which show that the Stormer Viscosimeter and Efflux-Tube Viscometer measure different viscous properties of tomato puree than the Bostwick and Adams Consistometers and the Blotter Test.

This study was undertaken in an attempt to evaluate various methods of measuring consistency of tomato puree (pulp). Tomato puree at the present time is bought and sold on the basis of color, absence of defects and solids content. However, during the quality evaluation of tomato puree, it has been observed that considerable variation exists in the consistency of different samples of tomato puree with equivalent color, absence of defects and total solids content. In the new proposed rule on U. S. Standards for Grades of Tomato Sauce *(11)*, consistency has been proposed as a factor of quality which is to be measured objectively by means of the Bostwick Consistometer. This study was also undertaken to determine if a similar factor of quality should be considered for tomato puree.

Viscosity has been defined "as a measure of the force required to shear a fluid at unit rate. Consistency is a property related to viscosity or plasticity which is encountered in the case of suspensions. Suspensions do not exhibit true viscosity, but consistency can be measured by methods similar to those used for viscosity" *(6)*. Therefore, when measuring the viscosity of a suspension, an apparent viscosity value is obtained rather than a true viscosity value. For some purposes, consistency and apparent viscosity are considered to be synonymous terms *(6)*.

In this study, the Bostwick Consistometer, Adams Consistometer, Stormer Viscosimeter, Efflux-Tube Viscometer and the Blotter Test were used to measure objectively the viscous properties of tomato puree. Further, the interrelationship of these particular methods of measuring consistency or apparent viscosity was studied.

The Blotter Test has been used by the catsup industry to indicate high concentration of tomato solids. Smith *(8)* stated the "the blotter test is a function of the soluble solids in the catsup, aided perhaps by the insoluble particles of cell protoplasmic material in the syrup." The Blotter Test was made in this study to ascertain its value in relationship to consistency, apparent viscosity or other quality characteristics of tomato puree.

[a] Journal Paper No. 45-53 of the Ohio Agricultural Experiment Station, Wooster, Ohio.

[b] Presented at the Thirteenth Annual Meeting of the Institute of Food Technologists, Boston, Mass., June 22, 1953.

PROCEDURES

The samples of tomato puree used in this study to evaluate the various methods of measuring consistency were manufactured under pilot plant conditions and represented a wide range of total solids contents and consistencies, since varying raw product compositions and both "hot" and "cold" break processes were used. The consistency of approximately 160 canned tomato puree samples was measured (at 70° F. unless otherwise noted) by each of the following objective methods:

Adams Consistometer. The Adams Consistometer (Figure 1) was designed and constructed by Adams and Birdsall of the Kroger Food Foundation *(1)*. This instrument and its use has been described in the Food and Drug Administration's Minimum Standards of Quality for Canned Cream Style Corn for determining consistency *(9)*.

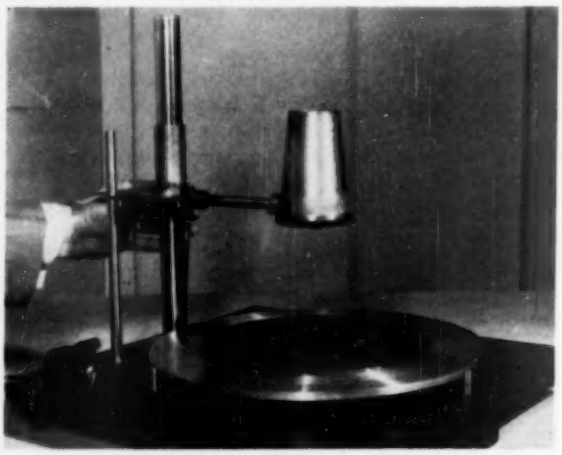

Figure 1. The Adams Consistometer.

The Adams Consistometer was first leveled by means of the adjustment screws and levels provided on the instrument. The hollow truncated cone was then seated on the center of the disk. A 200-ml. portion of each sample of tomato puree was poured into the cone. The cone was then raised quickly, and after 30 seconds, the consistency of the puree was determined by recording the extent of flow of the product at four equidistant points as indicated on the calibrated disk. The four values thus determined were averaged to obtain an average consistency value for the product.

Figure 2. The Bostwick Consistometer.

Bostwick Consistometer. The Bostwick Consistometer (Figure 2), developed by E. P. Bostwick of the U. S. Department of Agriculture in 1938, is officially used by the U.S.D.A. in establishing the score points for consistency of tomato catsup *(10)*, and has been proposed for establishing the score points for consistency of tomato sauce *(11)*.

The consistometer was first leveled by adjusting the leveling screws provided on the instrument. The gate was then closed and locked by engaging the trigger release mechanism. The holding compartment thus formed at one end of the consistometer was filled with a portion of the sample of tomato puree and leveled off even with the sides of the compartment. The gate was then released by the trigger while holding the instrument steady. After 30 seconds, the consistency was measured by recording the extent of flow on the calibrated scale, taking an average of the values at the center and sides of the scale.

Stormer Viscosimeter. The use of the Stormer Viscosimeter (Figure 3) for the measurement of the viscosity of foods has recently been described *(4)*.

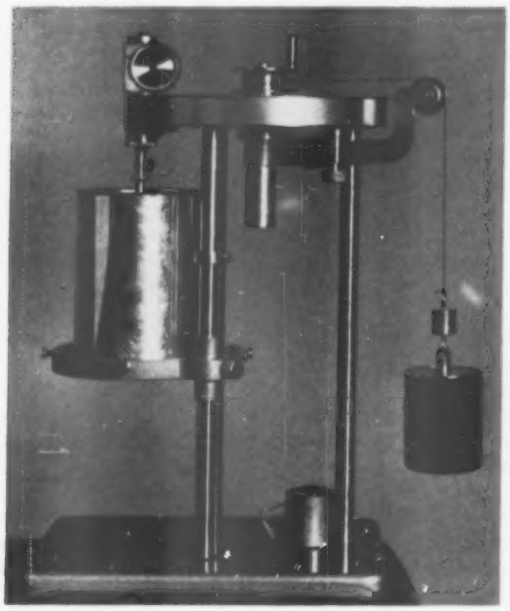

Figure 3. The Stormer Viscosimeter.

The viscosimeter was placed on a bench so that the driving weight could drop through an unobstructed distance of approximately 40 inches. Samples were measured using driving weights of 130 and 250 grams. A cylindrical rotor was used throughout the study. The container (No. 2 tin can) of tomato puree which had been well mixed was placed on the platform, and then raised until the rotor was centrally immersed in the puree to a depth one-half inch above the top of the rotor. The driving weight was then raised, the brake released, and after 10 untimed revolutions were indicated on the counter (in order to allow the rotor to attain constant speed) the timing period was started. The following 100 revolutions of the rotor were timed by a stopwatch. Two readings were taken on each sample of tomato puree and averaged.

Efflux-Tube Viscometer. Efflux viscometers measure the time necessary for a quantity of fluid to pass through an orifice or capillary under standard pressure. The Saybolt Viscometer, an efflux type, is the official ASTM instrument for measuring the viscosity of viscous liquids *(7)*. A specially designed efflux-tube viscometer (Figure 4) was used in this study to determine the

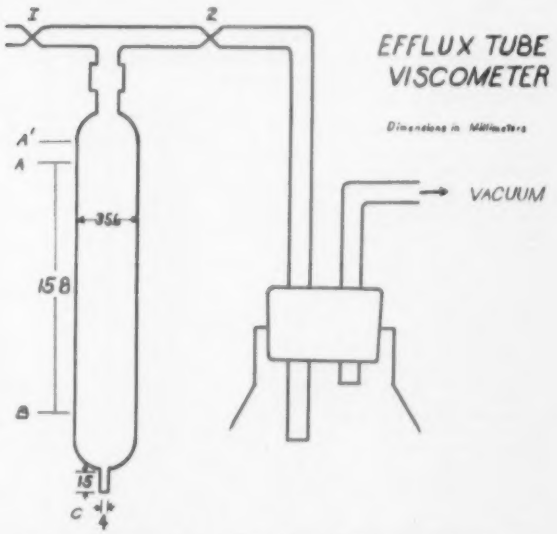

Figure 4. Diagram of Efflux-Tube Viscometer showing vacuum apparatus.

consistency or apparent viscosity of tomato puree in this manner.

The sample of tomato puree was raised at position C so that the lower tube was immersed in tomato puree at all times to prevent inclusion of air. A vacuum was then drawn in order to fill the tube to A'. The vacuum line was closed and the sample container placed below C so that the sample could flow back into the container. The vacuum was then released to allow the sample to flow out of the tube. The rate of flow from Line A to Line B (previously calibrated at 150 ml.) was timed with a stopwatch. After each determination, the tube was flushed with clean water, allowed to drain, and blotted to remove the water remaining in tube C.

The Blotter Test. Three-inch squares of standard grade white desk blotters were used for the Blotter Test; 1.5 ml. of the sample was placed onto the center of the blotter. After 10 minutes had elapsed, the outer limit of the wetted area was marked, and 2 perpendicular diameters were measured with a vernier caliper in centimeters. The readings were then averaged to obtain the Blotter Test value.

Total solids. The refractive indices of the purees were determined with an Abbe "56" Refractometer. The refractive indices were then converted to percent total solids by using the chart compiled by the Heekin Can Company, Norwood, Ohio, from N.C.A. Bull. 27-L, 1941 (Rev. 1945) *(3)*.

Effect of temperature on consistency and viscosity measurements. It has been shown that viscosity is inversely related to temperature *(2)*. In order to determine the effect of temperature on the consistency or apparent viscosity values, measurements were made with the Bostwick Consistometer, Stormer Viscosimeter, and Efflux-Tube Viscometer using identical samples for each instrument and varying the temperature from 70° F. to 210° F. Sealed containers of tomato puree were heated in boiling water for one hour until the entire contents of the container had

reached a temperature of 212° F. These containers were then opened and the measurements were made at graduated temperatures as the tomato puree cooled to 70° F. Temperature of the puree was measured just prior to consistency measurements on all instruments.

DISCUSSION

The correlation coefficients for the values obtained from objective measurement of tomato puree studied in this work are presented in Table 1. All of these correlation coefficients are significant at the 1% level; however, in this study, correlation coefficients less than 0.80 were not considered valid for prediction purposes.

TABLE 1
Correlation of objective consistency measurements[1] of tomato puree

Measurements correlated	Correlation coefficient ("r" values)	Coefficient of determination ("%" values)
Bostwick vs. Adams	−0.94**	88.4
Bostwick vs. Stormer (130 g. wt.)	−0.72**	51.8
Bostwick vs. Stormer (250 g. wt.)	−0.55**	30.3
Bostwick vs. Efflux-Tube	−0.59**	34.8
Bostwick vs. Blotter	+0.75**	56.3
Bostwick vs. Total Solids	+0.34**	11.6
Adams vs. Stormer (130 g. wt.)	+0.76**	57.8
Adams vs. Stormer (250 g. wt.)	+0.64**	41.0
Adams vs. Efflux-Tube	+0.67**	44.9
Adams vs. Blotter	−0.73**	53.3
Stormer (130 g. wt.) vs. Stormer (250 g. wt.)	+0.68**	46.2
Stormer (130 g. wt.) vs. Efflux-Tube	+0.91**	82.8
Stormer (130 g. wt.) vs. Blotter	−0.67**	44.9
Stormer (130 g. wt.) vs. Total Solids	+0.31**	9.6
Stormer (250 g. wt.) vs. Efflux-Tube	+0.93**	86.5
Stormer (250 g. wt.) vs. Blotter	−0.75**	56.3
Efflux-Tube vs. Blotter	−0.51**	26.0
Blotter vs. Total Solids	−0.34**	11.6

[1] All measurements made at 70° F.
** Indicates significance at the 1% level.

According to correlation coefficients given in Table 1 and as shown in Figure 5 and Figure 6, percent total solids is not a valid means of predicting consistency of tomato puree. McColloch *et al. (5)*, in reporting studies on tomato paste, have shown that consistency as measured by the Penetrometer is more directly related to pectin content than to total solids content, which indicates that in the case of tomato paste, total solids content

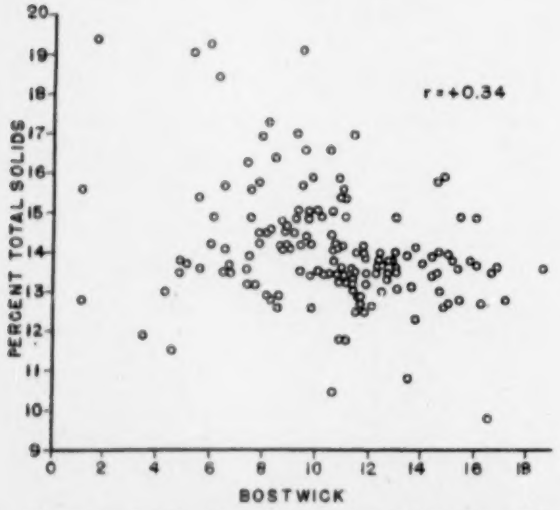

Figure 5. Relationship of Bostwick Consistometer values (cms.) to percent total solids of tomato puree. (70° F.)

may also not be a valid means of predicting consistency. In the cases of Bostwick vs. Percent Total Solids, Stormer (130 g. wt.) vs. Percent Total Solids, and Blotter vs. Percent Total Solids, a correlation coefficient of 0.34 or lower was found which is considerably less than the 0.80 minimum value used in this study for valid

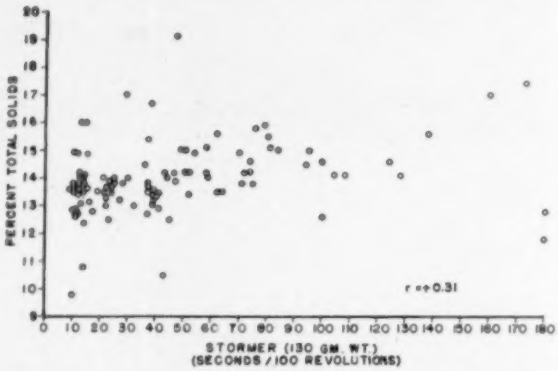

Figure 6. Relationship of Stormer (130 g. wt.) values (seconds/100 revolutions) to percent total solids of tomato puree. (70° F.)

prediction purposes. Thus, there appears to be a need for consideration of consistency as a separate factor of quality for tomato puree in addition to the factor of percent total solids.

The Bostwick Consistometer vs. the Adams Consistometer gave a correlation coefficient of —0.94, indicating that the instruments may be used interchangeably for measuring similar properties of consistency of tomato puree. Figure 7 gives the actual values and the regression line for the values obtained.

The Bostwick Consistometer vs. the Blotter Test gave a correlation coefficient of 0.75 and the Adams Consistometer vs. the Blotter Test gave a value of 0.74. This indicates that for tomato puree, the Blotter Test can not be used as a valid means of predicting consistency. Therefore, Bostwick and Adams Consistometer values for tomato puree can not be predicted with a high degree of accuracy from the Blotter Test values.

It should be pointed out, however, that in obtaining the Blotter Test values in this study, 10 minutes elapsed before the outer limit of the wetted area was marked on the blotter paper. It is possible that Blotter Test values may be used to indicate the tendency of the puree toward synerisis or "weeping" in addition to an evaluation of the consistency of tomato puree.

Consistency measurements as determined by the Stormer Viscosimeter and the Efflux-Tube Viscometer cannot be used to predict similar properties of consistency as measured by the Bostwick and Adams Consistometers. The correlation coefficients (Table 1) for Bostwick vs. Stormer (130 g. wt.), Bostwick vs. Stormer (250 g. wt.), Bostwick vs. Efflux-Tube, Adams vs. Stormer (130 g. wt.), Adams vs. Stormer (250 g. wt.), and Adams vs. Efflux-Tube are less than 0.80. Accordingly, these data indicate that the consistometers and viscosimeters used in this study measure different viscous properties of tomato puree. The Bostwick and Adams Consistometer values are not related linearly to

the Stormer Viscosimeter and Efflux-Tube Viscometer values which also indicate that these instruments measure different viscous properties of tomato puree. The Efflux-Tube Viscometer and the Stormer Viscosimeter can be used to predict similar properties of tomato puree as indicated by the correlation coefficient of +0.91

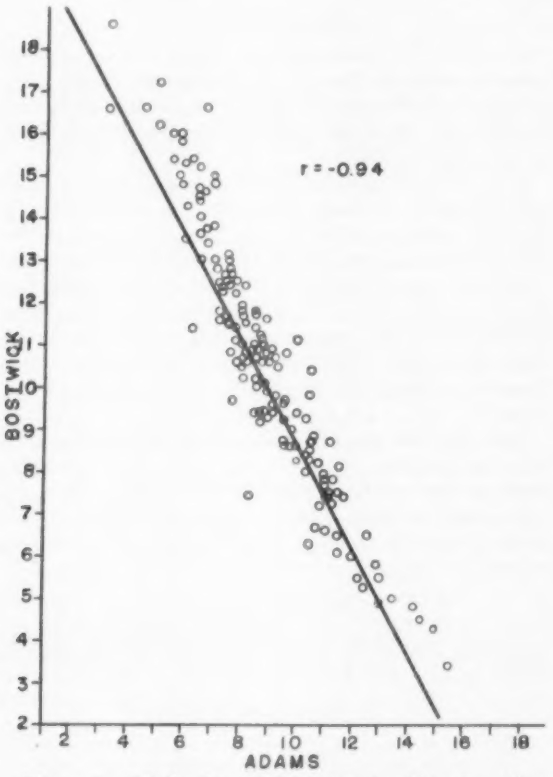

Figure 7. Relationship of Bostwick Consistometer values (cms.) to Adams Consistometer values of tomato puree. (70° F.)

(Stormer 130 g. wt.) and +0.93 (Stormer 250 g. wt.) respectively (Table 1). The relationship of the Efflux-Tube Viscometer values to the Stormer Viscosimeter (130 g. wt.) values is presented in Figure 8.

According to Wilbur *(12)*, the FMC Consistometer was constructed to give a reproducible relationship between consistency and heat penetration measurements of cream style corn, since "the Brookfield, Stormer, and similar instruments cause a thin film of liquid contiguous to a smooth surfaced cylinder, or cup, to be set into laminar flow and the resultant drag, or the required force, is measured. While this method of measurement suffices to measure the characteristics of the liquid portion of the product it does not reflect the effect of kernels and suspended particles on the consistency of the material." With the above statement in mind it is believed that the Stormer Viscosimeter and Efflux-Tube Viscometer may measure the characteristics of the liquid portion of the tomato puree, but may not reflect the effect of the suspended particles on consistency in the same proportion as do the Bostwick and Adams Consistometers.

Plastic nature of tomato puree. Figure 9 is presented to show that tomato puree resembles plastic substances in nature; that is, a certain driving weight must be exceeded before flow is established *(6)*. When using the Stormer Viscosimeter, therefore, after standardizing with a liquid of known viscosity, driving weights should be chosen to achieve a standard speed. For individual quality control purposes, a similar curve should be plotted for each operation in order that a

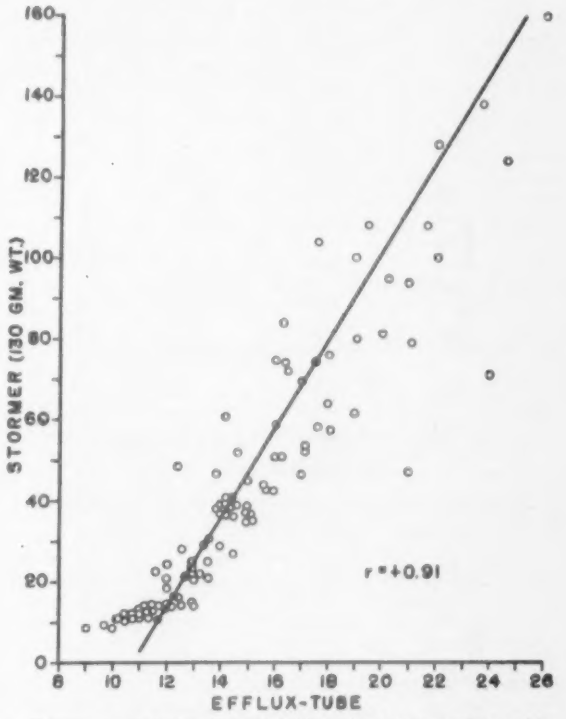

Figure 8. Relationship of Efflux-Tube Viscometer values (seconds/150 mls.) to values obtained with the Stormer Viscosimeter (130 g. wt.). (70° F.)

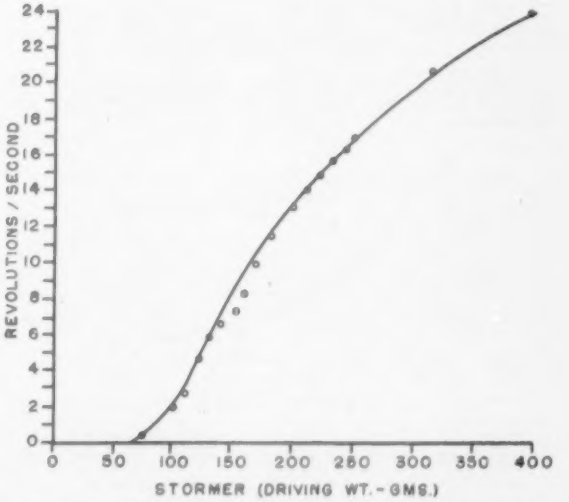

Figure 9. Consistency curve for tomato puree illustrating its plasticity. (70° F.)

driving weight would be chosen that will not be in the "static flow" region since the viscous properties of tomato puree will vary.

Effect of temperature on consistency measuremeats. The Bostwick Consistometer gives a straight line relationship, i.e., flow decreases proportionally to temperature decrease within the range of 190° F. to 70° F. (Figure 10). The viscosimeters both give curved-line relationships, though the curves differ in nature. The Stormer Viscosimeter gives a "positive" curve, that is, accelerating more rapidly toward the higher temperature (Figure 11). The Efflux-Tube Viscometer also gives a "positive" curve, but the flow approaches a constant speed at the higher temperatures (Figure 12).

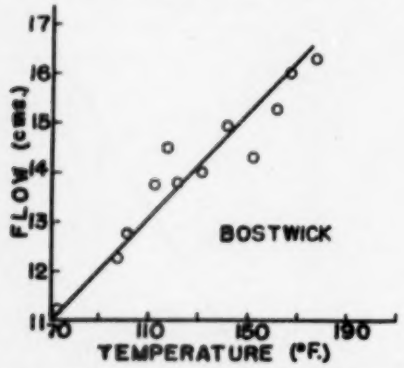

Figure 10. Effect of temperature within the range of 70° F. to 190° F. on Bostwick Consistometer values (cms.).

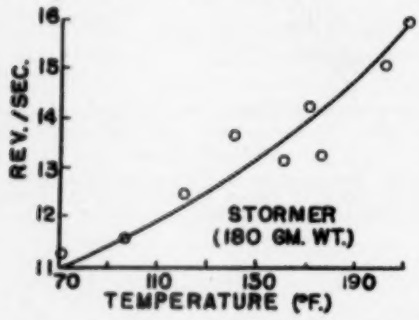

Figure 11. Effect of temperature within the range of 70° F. to 210° F. on Stormer Viscosimeter (180 g. wt.) values (revolution/second).

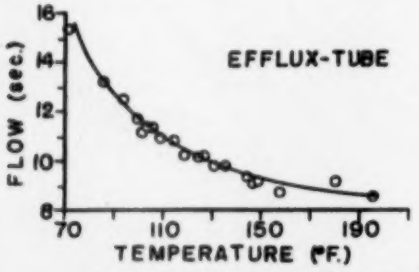

Figure 12. Effect of temperature within the range of 70° F. to 190° F. on Efflux-Tube Viscometer values (seconds-150 ml.).

It should be noted from these data that when making consistency measurements, temperature is a variable which must be controlled. Preferably, when measuring consistency of samples, the temperature should be standardized or the readings adjusted according to a previously calibrated chart for each instrument.

CONCLUSIONS

This study has pointed out the variation in consistency values at equivalent total solids content. Thus, consistency should be considered as well as total solids and other factors of quality when determining the grade of tomato puree (pulp).

Data presented indicate that the Bostwick and Adams Consistometers measure properties of consistency or apparent viscosity different from those measured by the Stormer Viscosimeter and the Efflux-Tube Viscometer.

Consistency measurements made with the Stormer Viscosimeter and the Efflux-Tube Viscometer are shown to evaluate similar viscous properties of tomato puree. Also, the Adams and Bostwick Consistometers are shown to evaluate similar viscous properties of tomato puree.

Data are also given which indicate that the viscous property of tomato puree is plastic in nature. Finally, when making consistency measurements with any of the instruments studied, temperature is a variable which must be controlled or a pre-determined correction must be made.

Acknowledgments

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Sensory Test Methods. I. The Triangle Intensity (T-I) and Related Test Systems for Sensory Analysis

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The method presented here can be used for the estimation of levels of significance for replicated judgments of two or more samples that represent no more than one difference. Increased efficiency is attained by the inclusion of weighted values for partially correct judgments.

The triangle test, comprising three samples of which two are duplicates, is widely used for determining the probability that a difference exists between the duplicates and the odd sample. Considerable information is lost in the use of this test if intensity designation is not made or if it is utilized only for those judgments in which odd sample choice is correct. If the only information requested in the test is selection of the odd sample from three samples presented, the probability of correct selection by chance is, of course, ⅓. If in addition to odd-sample selection, the individuals are required to judge whether the odd sample is stronger or weaker in intensity of some particular quality, the probability of a correct judgment by chance alone is reduced to ⅙. Thus the requirement that the intensity of some property of the samples be designated decreases the number of tests required to detect a difference at a given level of significance. The usual procedure in analyzing the results of tests requiring intensity designation has been to disregard those judgments in which odd-sample selection was incorrect. However, recent experience at this Laboratory and published results of Byer and Abrams *(1)* have shown that partially correct intensity designations were made in significantly greater numbers than would be expected by chance in the cases in which odd-sample selection was incorrect. Consequently, the need for a method of analysis utilizing partially correct as well as completely correct judgments was indicated. Although Byer and Abrams did not utilize these partially correct judgments in their comparison of two-sample and triangle tests, they did suggest that discrimination might sometimes be better demonstrated by utilization of such judgments.

This paper presents a new method of evaluating the results of three-sample tests in which designation of intensity is required. All judgments, whether partially or completely correct, are evaluated in terms of an I value which is directly related to the probability of chance occurrence of the judgments. Since this method differs considerably from the presently accepted version of the triangle test, it will be referred to in the following discussion as the T-I test (triangle-intensity). The four-sample test evaluated in a similar manner would then be a Q-I test (for quadrangle-intensity) and so on.

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EVALUATION OF POSSIBLE JUDGMENTS

Table 1 shows the method of determining the I values for various arrangements of 2, 3, and 4 samples. Part A can be evaluated directly from tables for the binomial distribution of probability. It is included here, however, since appropriate tables may not be readily available and also to illustrate the general applicability of the method. The letters *w* and *s* are used to designate whether the sample is judged weaker or stronger in intensity of the quality being tested. For purposes of calculation, the first judgment in column 1 of each section is considered to be correct. The remaining are the other possible judgments that could be made.

In section B of Table 1, the chance occurrence of the possible judgments no longer follows a binomial distribution. In this section, if the first judgment is considered to be correct, then judgments 2 to 5 are partially correct since they have 1 or 2 samples correctly designated as to intensity and the 6th judgment is completely wrong.

The expectancy of making the correct judgment by chance is ⅙. The chance expectancy of making one of the two judgments with two correct intensity designations is ⅔ and similarly for one correct intensity judgment the chance expectancy is also ⅔ while for none correct it is ⅙. The relative value of each possible judgment is based on the chance expectancy of judging that number *or more* of the 3 samples correctly rather than on the expectancy for that specific number of correct choices. Thus, the partial sums of the probabilities give the expectancy of correctly designating the intensity for the corresponding number or more of the samples. The mid-range points are the mid-points of each class range of the partial sums and the I values are the mid-range points cleared of fractions. The use of the mid-range points represents a correction required to maintain the symmetry of the distribution of the I values. These I values are therefore weighted according to the probability of their selection by chance, the correct judgment receiving the lowest I value and the partially correct and incorrect judgments receiving higher I values in inverse proportion to the number of correct intensity designations.

In sections C, D, and E of Table 1, which give the I values for intensity differentiation of 4 samples, the values from sections C and D would be used where the judge is informed as to the manner in which the samples have been divided and section E when he is not so informed. Obviously, the person conducting the test will know the manner of division and is therefore automatically excluded from participation in the judging if the test is being evaluated according to section E.

ANALYSIS OF VALUES FOR REPLICATED JUDGMENTS

The principal importance of utilizing the partially correct judgments lies, of course, in the possibility of attaining greater efficiency by reducing the number of replications required to detect a difference at a given level of significance. Since the probability of chance occurrence of the I values for correct, partially correct, and incorrect judgments of the T-I test (Table 1) does not follow a distribution for which tables are available, the method of normal approximation for sums was used to calculate the curves shown in Figure 1. These curves show the total of I values for replicated judgments, expressed as percentage of the number of replications times the range, as a function of the number of replications for three commonly used levels of significance. (The range used here is the least common denominator of the mid-points of the probability class intervals. In terms of probability, the range is always from 0 to 1.) This approxima-

TABLE 1

The calculation of I values for correct, partially correct, and incorrect judgments for various arrangements of two, three, and four samples which include only one possible difference

Possible judgments	Correct judgments	Chance expectancy	Partial sums	Mid-class points	I value
A. Intensity differentiation of two samples. Range: 0 to 4					
w s	2	1/2	1/2	1/4	1
s w	0	1/2	2/2	3/4	3
B. Intensity differentiation of three samples. Range: 0 to 12					
w s s	3	1/6	1/6	1/12	1
w w s	2	1/6 } 2/6	3/6	4/12	4
w s w	2	1/6 }			
s s w	1	1/6 } 2/6	5/6	8/12	8
s w s	1	1/6 }			
s w w	0	1/6	6/6	11/12	11
C. Intensity differentiation of four samples divided into two pairs. Range: 0 to 12					
w w s s	4	1/6	1/6	1/12	1
w s w s	2	1/6			
w s s w	2	1/6 } 4/6	5/6	6/12	6
s w w s	2	1/6			
s w s w	2	1/6			
s s w w	0	1/6	6/6	11/12	11
D. Intensity differentiation of four samples divided into one of one strength and three of the other. Range: 0 to 16					
w s s s	4	1/8	1/8	1/16	1
s w s s	2	1/8			
s s w s	2	1/8			
s s s w	2	1/8 } 6/8	7/8	8/16	8
w w s s	2	1/8			
w s s w	2	1/8			
s s w w	2	1/8			
s w w w	0	1/8	8/8	15/16	15
E. Intensity differentiation of four samples divided either 2-2 or 1-3. Range: 0 to 28 (two sets of I values are required here and are used according to the way in which the division is made.)					
Samples divided 2-2					
w w s s	4	1/14	1/14	1/28	1
w s s s	3	1/14			
w w w s	3	1/14 } 4/14	5/14	6/28	6
s w s s	3	1/14			
w w s w	3	1/14			
s w s w	2	1/14			
w s s w	2	1/14 } 4/14	9/14	14/28	14
s w w s	2	1/14			
w s w s	2	1/14			
s s w s	1	1/14			
s s s w	1	1/14 } 4/14	13/14	22/28	22
s w w w	1	1/14			
w s w w	1	1/14			
s s w w	0	1/14	14/14	27/28	27
Samples divided 1-3					
w s s s	4	1/14	1/14	1/28	1
w s s s	3	1/14			
w s w s	3	1/14 } 3/14	4/14	5/28	5
w s s w	3	1/14			
s w s s	2	1/14			
s s w s	2	1/14			
s s s w	2	1/14 } 6/14	10/14	14/28	14
w s w w	2	1/14			
w w s w	2	1/14			
w w w s	2	1/14			
s w s w	1	1/14			
s s w w	1	1/14 } 3/14	13/14	23/28	23
s w w s	1	1/14			
s w w w	0	1/14	14/14	27/28	27

tion is least reliable when the number of replications is small but improves rapidly as the number increases. In order to determine the reliability of the approximation, it was necessary to make calculations such as those shown in Table 2. Table 2 illustrates the calculation of the probability of chance occurrence of the possible total values or lower total values for three replications of the triangle test.

Probabilities were calculated in this manner for 3, 4, 5, 6, and 12 replications of the triangle test. Three minor discrepancies

TABLE 2

Calculations of the probabilities of the chance occurrence of the possible total or lower total values in three replications of the T-I test

Total values[1]	Combinations[2]	Permutations[3]	Probabilities[4]	Partial sums[5]
3	1 1 1	1	0.00463	0.00463
6	1 1 4	6	0.02778	0.03241
9	1 4 4	12	0.0556	0.08797
10	1 1 8	6	0.02778	0.11575
12	4 4 4	8	0.03704	0.15279
13	1 1 11	3 } 27	0.12500	0.27779
13	1 4 8	24 }		
16	1 4 1	12 } 36	0.16666	0.44445
16	4 4 8	24 }		
17	1 8 8	12	0.05556	0.50000
19	4 4 11	12	0.05556	0.55556
20	1 8 11	12 } 36	0.16666	0.72222
20	4 8 8	24 }		
23	1 11 11	3 } 27	0.12500	0.84722
23	4 8 1	24 }		
24	8 8 8	8	0.03704	0.88426
26	4 11 11	6	0.02778	0.91204
27	8 8 11	12	0.05556	0.96759
30	8 11 11	6	0.02778	0.99537
33	11 11 11	1	0.00463	1.00000

[1] Total values possible in 3 replications (column 1) are the sums of the combinations of values in column 2.

[2] Column 2 consists of all combinations of the values 1, 4, 8, and 11 that are possible in 3 replications.

[3] Column 3, the number of possible arrangements of each combination of values, is found from a modification of the formula for permutations:

$$Z = \frac{S!}{a!\,b!\,\ldots} N_1^{n_1} N_2^{n_2} \ldots$$

where Z = total possible arrangements (permutations)
S = number of items
$a, b, \ldots$ = numbers of identical items
$N_1, N_2 \ldots$ = number of ways of arriving at each item
$n_1, n_2 \ldots$ = number of occurrences of items which may be arrived at in $N_1, N_2 \ldots$ ways.

The following illustrates the calculations of the number of possible arrangements of values giving a total value of 13 in three replications of the triangle test (see Table 4):

Combinations of values from each replication totaling 13	Permutations of each combination
1 1 11	$Z = \frac{3!}{2!} = 3$
1 4 8	$Z = \frac{3!}{1!}(2)\ (2)^* = \frac{24}{27}$

* A value of 4 or 8 can be obtained from either of 2 possible judgments (see Table 1).

The following example illustrates the calculation of the number of possible arrangements of values giving a total value of 26 in 6 replications of the triangle test (complete table for 6 replications not included):

Combinations of values from each replication totating 26	Permutations of combination
1 1 1 4 8 11	$Z = \frac{6!}{(3!)}(2)\ (2) = 480$
1 1 4 4 8 8	$Z = \frac{6!}{(2!)\ (2!)\ (2!)}(2)^3\ (2^3)^{**} = 1440$
1 1 1 1 11 11	$Z = \frac{6!}{(4!)\ (2!)} = 15$
	Total 1935

** A value of 11 or 8 can be obtained from either of 2 possible judgments and each occurs 2 times in this combination.

[4] Column 4 derived from column 3 by dividing the number of possible arrangements by the sum of all possible arrangements (e.g. $\frac{1}{216} = .00463$).

[5] Column 5 derived by addition of corresponding values from column 4 and all preceding values in column 4 (e.g. 0.00463 + 0.02778 = 0.03241).

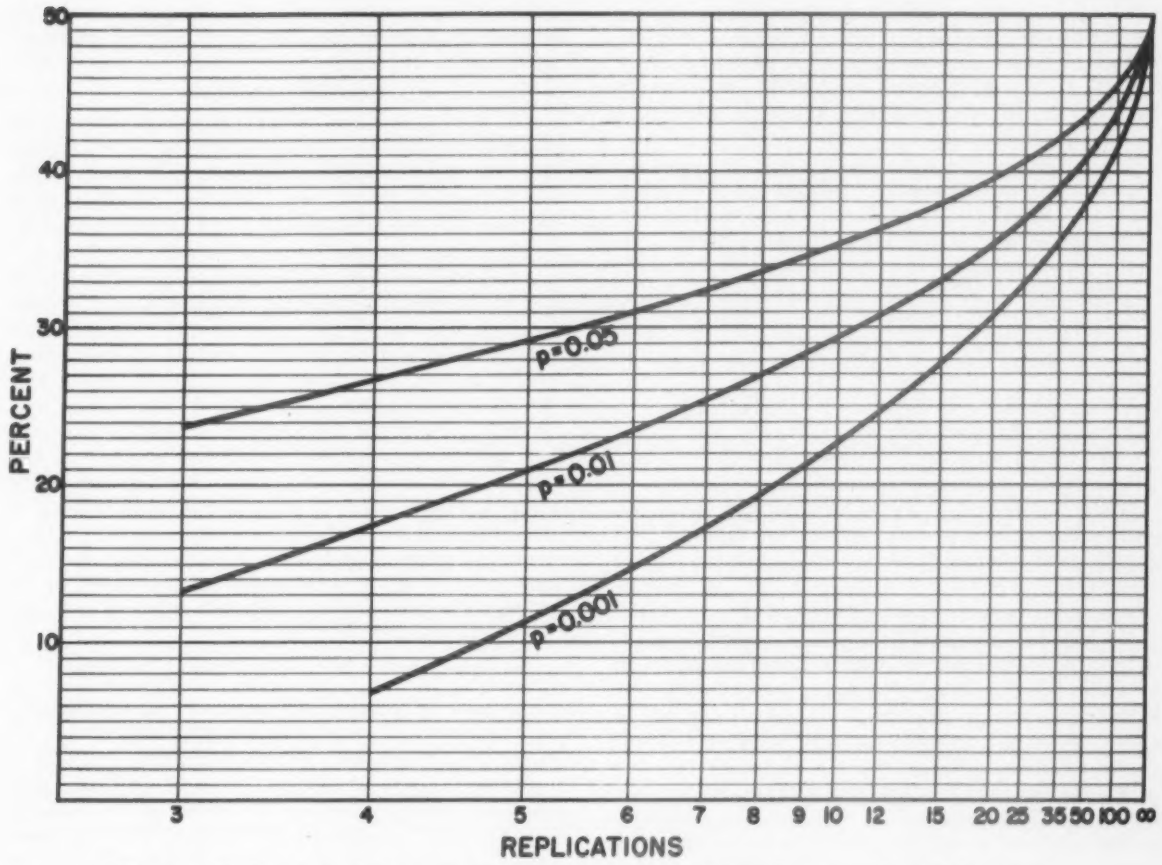

Figure 1. Significance levels for sums of I values for replicated judgments as percentage of the range.

were found. For instance, the curves of Figure 1 show that a total value of 4 (8.5% of a possible total of 48) in 4 replications is just above the 0.001 line, whereas the probability is actually 0.008. Also, a total of 22 (30.5% of 72) in 6 replications would be counted as significant at the 0.05 level, while the probability is actually 0.069 and a total of 36 (25% of 144) in 12 replications is just above the 0.001 line instead of just below as it should be. None of these discrepancies is greater than one unit and in view of the increasing exactness of the approximation as the number of replications increases, it would be safe to assume that any other discrepancies will be no greater. From the curves shown on Figure 1 it is therefore possible to determine the significance level of total values for any number of replications of the T-I test (or related tests) or to determine the total value required for a given level of significance with ample accuracy for most purposes. For instance, to find the total value for 5 replications of the T-I test that would be significant at the 5% level, the procedure would be as follows: Referring to Figure 1 it is found from the $p = 0.05$ curve that for 5 replications the total value should be approximately 29% of the range of 60, or 17.4. Since fractional values are not possible, the decimal is dropped and a total value of 17 or less is required for significance at the 5% level.

DISCUSSION

In most applications of sensory testing, the information sought is the answer to two questions: first, is there a difference between samples and second, in which direction does the difference lie? Generally, the second question is of equal importance to the first and the probability of the occurrence by chance of the choice of direction of the difference should therefore be combined with the probability of chance detection of the difference in the analysis of test results.

The desirability of combining probabilities has been recognized previously in two methods that have been used for analysis. In both of these methods, the intensity differentiation is considered only for those results where duplicate samples are correctly identified. In one method, these correctly identified results are then analyzed for intensity differentiation as pairs *(1)* and in the other method the probability of correct identification of duplicates ($p = \frac{1}{3}$) is multiplied by the probability of correct intensity differentiation ($p = \frac{1}{2}$) to obtain the probability of both events occurring at the same time ($p = \frac{1}{6}$) *(2, 3)*. Neither of these methods permits utilization of the information contained in the partially correct test results. The greater part of this missing information is contained in test results where the odd sample choice in the triangle test is incorrect, but two of the three samples have been correctly differentiated as to intensity [Table 1 and *(1)*]. The experimental evidence that these partially correct judgments occur in significantly greater numbers than would be expected by chance, when it is known that there is a difference between samples *(1)*, clearly shows that they should be considered in determining the level of significance of a

series of judgments. The analysis described here is based entirely upon the number of samples that are designated correctly as to intensity so that the correct selection of the odd sample is incidental. The following illustrates the effect of inclusion of these judgments on the level of significance:

Figure 1 shows that when partially correct judgments as well as correct judgments are evaluated, total I values of 12, 13, 15, and 16 (11 and 14 are not possible) for 6 replications of the triangle test are significant at the 1% level. These totals may be arrived at from the following combinations of I values from each replication:

(a) $1+1+1+1+4+4=12$
(b) $1+1+1+1+1+8=13$
(c) $1+1+1+4+4+4=15$
(d) $1+1+1+1+1+11=16$
(e) $1+1+1+1+4+8=16$

When the levels of significance of the judgments giving these values is calculated on the basis of odd-sample selection alone (from the expansion of the binomial, $(p+q)^n=1$) it is found that combinations (a), (c), and (e) are not significant, that combination (b) is significant at the 5% level, and combination (e) at the 1% level. If the calculation of significance level is based on both odd-sample selection and intensity differentiation, then combination (c) is not significant, combinations (a) and (e) are significant at 5%, and (b) and (d) at 0.1%.

It is evident from the foregoing that failure to include intensity differentiation or partially correct judgments or both can lead to considerable error in the estimation of the probability of detecting a difference by chance. Thus, the utilization of both intensity differentiation and partially correct judgments in many cases can reduce the number of replications required for the detection of a difference at a given level of significance. As the number of replications becomes greater, it becomes possible to detect differences at a desired level of significance with an even greater proportion of these partially correct judgments which would not be considered in either of the alternate methods of evaluation.

It will be noted that no provision is made for judgments of "no difference." It is the authors' opinion that such judgments should not be permitted. If no difference exists among samples, that fact will of course be evident from the random arrangement of the responses. By not permitting the judge to escape the responsibility of making a decision it is felt that the test is rendered considerably more sensitive, particularly where it is possible to include partially correct judgments as with the method presented here.

Utilization of this method, or any other sensory test method, requires the exercise of considerable judgment on the part of those conducting the test. In this test, judgments with completely incorrect quality designations should be carefully checked to be sure that the judge understands the instructions and recognizes the quality for which the test is being conducted. If the entire panel should show a tendency to reverse the quality designation, then the possibility of a mistaken hypothesis or an error in sample preparation should be considered.

RELATED SYSTEMS

The curves shown in Figure 1 represent a general solution of the problem of approximating the probability of occurrence of various combinations of events where the individual events have differing probabilities of occurrence. They can therefore be used for any system of sample arrangement for sensory analysis where it is possible to determine the probability of occurrence of the various possible responses. The mid-class probabilities may of course be used directly. However, it is more convenient to use the whole numbers such as those represented by the I values, both for calculations and for the information of the judges as to their performance.

Table 1 shows the derivation of I values for two samples and various combinations of four samples as well as for three samples. It should be noted that where either a 2-2 or 1-3 division of four samples is possible, as shown in part E of Table 1, the chance expectancy ratio of the two possibilities is 3:4, so that for small numbers of trials it might be preferable to divide the arrangements according to this ratio rather than to take the random occurrence.

TABLE 3

Calculation of values for the selection of replicated samples only from three and four samples which include only one possible difference

Correct judgments	Correct judgments	Chance expectancy	Partial sums	Mid-class points	Value
A. Odd sample selection only from three samples. Range: 0 to 6.					
X O O	3	1/3	1/3	1/6	1
O X O	0	1/3 } 2/3	3/3	4/6	4
O O X	0	1/3 }			
B. Selection of pairs from four samples. Since the position of the fourth sample is determined after one pair is chosen, the values are the same as for odd sample selection from three samples.					
C. Odd sample selection only from four samples. Range: 0 to 8.					
X O O O	4	1/4	1/4	1/8	1
O X O O	0	1/4 }			
O O X O	0	1/4 } 3/4	4/4	5/8	5
O O O X	0	1/4 }			

Table 3 shows the derivation of values for selection of replicates from three or four samples without intensity designation. The probabilities for these tests can also be found in appropriate tables for the binomial distribution of probability. The values are included here as an illustration of the general applicability of the method and also for use where the tables are either not available or not sufficiently extended.

CONCLUSIONS

A method has been developed for the estimation of levels of significance for replicated judgments of two or more samples per replication that represent two treatments (no more than one difference).

The method has particular value where the judge is required to make an intensity or quality differentiation, since it provides for the inclusion of partially correct judgments in the estimate of level of significance. This

provision permits the attainment of increased efficiency by reducing the number of trials necessary to detect a difference at a given level of significance.

Acknowledgment

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The Effect of Variations in Moisture and Fat Content on the Juiciness and Tenderness of Bologna

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The effects of varying the moisture and fat content of bologna on the juiciness and tenderness of the product are shown. The results indicate that increasing proportions of fat or moisture are related to increases in juiciness and tenderness. Juiciness and tenderness varied more noticeably with changes in moisture content than in fat content and appeared to be principally dependent on the former.

Makers of bologna sausage consider juiciness and tenderness to be dependent on the proportions of fat and moisture in the products. However, there is no report available of a systematic study of the relationship of these components to palatability factors. Recently an opportunity was afforded to study this relation in samples also used in a study of the variance in chemical determinations of added moisture in bologna. The results of the latter work are described in the companion paper *(3)*. The samples of bologna were prepared for the specific study from carefully selected meats of known history which, of course, is not possible under commercial conditions. For detailed information on the composition and processing of the bologna it is suggested that reference be made to the paper mentioned *(3)*.

The present report concerns the variations of juiciness and tenderness produced by different proportions of fat and moisture. On a limited scale preference tests were also conducted. The results of these tests indicated that bologna containing intermediate proportions of fat and moisture were preferred by the majority of 80 individuals at the author's laboratory. The minority included some who preferred bologna which was extremely low or high in fat or moisture content. These data support the assumption that an optimum rather than a maximum juiciness and tenderness is generally preferable but afford no reliable basis for generalization regarding the proportions of fat or moisture or degree of juiciness or tenderness necessary to produce the most desirable palatability. Conducting large scale tests such as would be necessary to establish this was beyond the scope of the investigation.

The results reported in the following indicate that increasing proportions of fat and moisture are related to increasing juiciness and tenderness and that, within limits, fat and moisture may be regarded as interchangeable in their effects. The data indicating the ability of a taste panel to perceive changes in characteristics produced by variations in composition also afford a basis for judgment in formulating sausage recipes and, perhaps, in organizing and interpreting organoleptic tests, when the effects of varying fat and moisture are a consideration.

METHOD IN TASTE TESTS

Bologna from each batch was cut into slices of ⅛-inch thickness; these were further cut to provide 6 segments of approximately equal size and shape. One of these segments comprised a sample in paired tests which were performed by the method described by Cover *(1)*. Members of the taste panel were all experienced judges of meat and meat products; the panel consisted of the same 10 members throughout the tests. The test involved offering samples of bologna from each of two different batches to judges who selected the samples considered to be more tender. In the same way juiciness and flavor were judged in other sets of samples. Comparison of all combinations of samples of the 5 batches in a series required comparison of 10 pairs for each characteristic. Generally tests were repeated 3 times by each judge at 3 tasting sessions held in the morning and afternoon of one day and the morning of the following day; this involved a total of 300 judgments per series of bologna.

Statistical treatment of the data was made by the Chi-square method, using +1 for samples considered more tender (or other characteristic) and 0 for the other; or, if 2 samples were judged equal with respect to the characteristic, each was credited with +0.5. No difference was assumed to exist unless a Chi-square value of 3.841 (significance at the 5% level) or more was obtained. The results of the tests performed by the taste panel are shown in Table 1.

DISCUSSION

As shown in Table 1 it was possible to maintain a relatively constant ratio of fat to protein while varying the ratio of moisture to protein and vice versa. The

[a] Deceased.

TABLE 1
Relation of composition to tenderness, juiciness and flavor [1]

Series —lot no.	Ice, based on wt. meat	Added moisture in product	Moisture to protein ratio	Fat to protein ratio	Sample rated [2]	
					More tender than	More juicy than
	%	%				
I-1	10	2.0	4.15:1	1.75:1	....	
I-2	18	7.4	4.57:1	1.83:1	1	1
I-3	22	10.1	4.80:1	1.71:1	1	1
I-4	30	14.8	5.25:1	1.85:1	1, 2, 3	1, 2, 3
I-5	45	20.6	5.82:1	1.70:1	1, 2, 3, 4	1, 2, 3, 4
II-1	15	4.7	4.35:1	1.77:1	....	....
II-2	22	7.4	4.54:1	1.59:1	1	1
II-3	30	10.1	4.77:1	1.65:1	1, 2	1
II-4	15	3.0	4.21:1	1.55:1	....	1
II-5	30	11.5	4.89:1	1.60:1	2, 4	2, 4
III-1	22	3.9	4.25:1	.87:1	....	....
III-2	22	6.3	4.43:1	1.21:1	1	1
III-3	22	5.6	4.44:1	1.51:1	1, 4	1
III-4	22	8.3	4.66:1	2.12:1	1, 2	1
III-5	22	9.7	4.84:1	2.61:1	1, 2, 3, 4	1, 2, 3, 4
IV-1	15	6.8	4.53:1	2.03:1	....	....
IV-2	20	10.0	4.80:1	1.95:1	....	1
IV-3	30	16.1	5.42:1	2.14:1	1, 2	1, 2
IV-4	36	18.5	5.65:1	2.05:1	1, 2, 3	1, 2
IV-5	44	23.2	6.21:1	2.04:1	1, 2, 3, 4	1, 2
V-1	30	11.5	4.85:1	1.32:1	....	....
V-2	30	12.2	4.95:1	1.61:1	....	1
V-3	30	13.6	5.16:1	2.15:1	....	1
V-4	30	13.5	5.26:1	2.80:1	1	1, 2, 3
V-5	30	11.1	5.08:1	3.38:1	1, 2	1, 2, 3

[1] Data reported from organoleptic tests include only those found statistically significant at the 5% or a lower level.
[2] No variation in flavor was found on varying composition.

proportions of cure and spices were arbitrarily chosen, weights of curing agents being based on the weights of meat and the weights of spices based on the combined weights of meat and ice. Since no differences in flavor were detected between samples in any of the tests, it is concluded that calculation of the amount of cure on the basis of the weight of meat, and of spices on the basis of the combined weights of meat and ice, is a satisfactory means of obtaining relatively constant flavor.

Further examination of Table 1 indicates that increasing proportions of fat or moisture are related to increases in the juiciness and tenderness of the product. The findings indicate that fat as well as moisture is an important factor in producing juiciness; this juiciness was of the type that was apparent to tasters and not necessarily related to the amount of expressible or free liquids in the product. In other work, evidence has been presented that fat plays an important role in the apparent juiciness of meat *(2)*. Since both fat and moisture produced tenderness and juiciness, they may be regarded as more or less interchangeable and, within limits, equivalent degrees of tenderness or juiciness should be obtainable with a variety of different proportions of fat and moisture.

In these experiments conditions conformed with procedures normally followed in the sausage industry; thus, meat emulsions were chopped in the silent cutter until the temperature reached 56-57° F. and the time allowed for comminution consequently varied with the proportion of moisture (ice) added to the meat. In Series II this procedure was varied so as to include three lots, 4, 2 and 5, containing 15, 22, and 30% added ice, respectively, based on the weight of meat, each of which was comminuted in the silent cutter for 10 minutes. The bologna (lot 5) prepared with 30% added ice was judged more juicy and tender than lots 2 and 4 which had been prepared with 15.0 and 22.0% added ice. No difference was found between samples from the latter two lots of bologna. These results were consistent with the premise that increased moisture produced increased juiciness and tenderness. The extent of the effects of variations of the amount and temperature of comminution remains to be determined.

The ability of the judges to distinguish between samples prepared with small differences in levels of ice was greater than their ability to distinguish between similar changes in levels of fat. Thus, in tests on Series I, in which ice was added to the extent of 10, 18, 22, 30 and 45%, based on the weight of meat, differences in juiciness and tenderness between samples on adjacent levels were recognized, except that between samples made with 18 and 22%. In tests on Series IV the differences in tenderness were recognized between adjacent levels, except that between the two lowest levels in using 15, 20, 30, 36 and 44% ice. With respect to juiciness, no difference was found in relation to the use of levels of 30, 36 and 44% ice. Much less fine distinctions were made in judging samples in Series III and V in which the effect of variations of fat were studied, even though the fat content of samples in Series III and V varied over a broader range than the moisture content of samples in Series I, II and IV. It would appear therefore that the juiciness and tenderness of bologna were considerably more dependent on moisture than fat content.

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Apparent Density of Sausage Meats

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The volume of sausage meats in casings and other meat pieces can be measured by displacement of water in a calibrated cylindrical tank. The Apparent Density of the piece is the ratio of the weight of the piece, divided by the volume found, multiplied by the weight of a cubic inch of water. All meat wieners and bologna are lighter than water, Apparent Density about 0.95. Salami, New England, and dry sausage are heavier, Apparent Density about 1.03. Meat pieces are quite variable depending on the amount of fat, Apparent Density 1.04 to 1.08. For a given size of artificial casing the weight of sausage it will contain at proper diameter can be calculated.

The volumes of stuffed casings were of interest originally to determine whether the smoking and baking in the smokehouse produced an increase in volume of the pieces and consequent strain on the casings. With the volume and weight measurements found, the Apparent Density of the meats could be learned.

Volume measurements on the pieces during smoking and baking in the smokehouse were sometimes found to be larger than when the pieces were "green." This increase was about 2% over the original volume. The pieces usually showed the same volume throughout processing though the weight continued to decrease. Observations show that the dry casing exerts a restraining action on the expanding meat. The measurement of volume when the hot sausage piece is first submerged in the water is slightly smaller than after waiting 10 or 15 seconds. The dry casing on the hot finished piece is tight, while after soaking the casing the piece is softer to the touch and the volume measurement slightly larger. After cooler chilling to about the same temperature as when stuffed (55 to 65° F.) the pieces showed substantial decrease in volume. These decreases approximately paralleled the decreases in weight. Rendering of fat from the bottom tie makes the changes in processing not strictly quantitative but the shrink and volume change make the apparent density of the finished pieces about the same as the original "green" pieces.

METHODS

For the volume measurements a cylindrical tank (8½ in. diam., 18 in. high) with a side arm and sight glass was used; it was fitted with a sliding scale rule. The rule was zeroed at the meniscus in the side arm when the tank was about half full of water. With submersion of the piece, the number of inches of rise in the sight glass could be read directly from the rule. The tank accommodated pieces in the range of 100 to 350 cu. in. in volume. For each inch of vertical rise the tank had a volume of 56.8 cu. in. The slight error of the volume of water from the rise in the sight glass was not corrected.

To check on the overall accuracy of the tank for measuring volumes by displacement, 4 imitation wooden sausages, turned on a lathe in the form of cylinders with hemispherical ends, were measured and the volumes calculated. The diameter of the piece subtracted from the length of the piece gives the length of cylindrical portion. The diameter is also the diameter of the sphere consisting of the two ends. The sum of the cylinder and sphere volumes is the calculated volume of the piece, i.e. ($\frac{1}{4}$ pi x D^2 x L.) plus ($\frac{1}{6}$ pi x D^3) = volume.

The volumes were then determined by submersion in the tank. The agreement was within 1%. The two extremes are shown:

TABLE 1

Piece	Calculated volume	Displacement volume	Weight	Apparent density
	cu. in.	*cu. in.*	*oz.*	
1	221.1	220	60.5	0.48
2	325.2	324.7	103	0.55

The Apparent Densities found are in the range of the specific gravity of the wood from which the pieces were turned. The Apparent Densities were found by the calculation of: Wt. in oz./Displacement volume x Wt. of a cubic inch of water [0.574 oz. at 68° F. (20° C.)].

The weights were found with a Chatillon hand scale. The weight of the casing was not deducted from the weights of pieces.

RESULTS AND DISCUSSION

The purpose of determining the Apparent Densities was the calculation of the weights of various sausage meats to fill casings at specified dimensions. The data show that meat pastes prepared in a cutter, such as wiener and bologna emulsions, are of lighter density than water. Cooked salami, New England ham sausage or salami formulations meant to be air dried are heavier than water. Fresh pork sausage is generally even lighter than bologna or wiener meat. The Apparent Density selected for use in casing calculations for the three classes of meat became:

TABLE 2

	Apparent density	Weight per cubic inch
Bologna and Wieners	0.95	0.546
Salami, New England, Dry Sausage	1.03	0.59
Fresh Pork Sausage	0.91	0.522

Where an all meat product was measured, bologna and wieners floated in water while cooked salami, New England and dry salami meat formulations sank. The two reasons for this weight difference are (a) in order to make tender wieners and bologna more fat is added in formulating, and (b), the fine cutting that these meats are subjected to incorporates more air than in the more coarsely ground meats. As can be seen from the examples in Table 3, the formulations to which cereal binders or expanders were added were much more dense. These pieces are marked with an asterisk.

The casing size designations are those used in the trade for cellulose casings. These numbers, except for the length, are nominal and not a measurement.

Table 4 records the volume weight and Apparent Density of some pieces of pork in various stages of processing.

TABLE 3

Casing and Product	Uncooked "green"	Cooked and cold	Weight Percent shrink	Uncooked "green"	Cooked and cold	Volume Percent shrink	Uncooked "green"	Cooked and cold
	Weight in ounces	*Weight in ounces*		*Volumes in cu. in.*	*Volumes in cu. in.*		*Apparent densities*	*Apparent densities*
3¼ x 20" Bologna	129	120	7.0	237.8	220	7.5	0.95	0.95
3¼ x 24" Bologna	156	148	5.1	291	273	6.1	0.94	0.95
3¼ x 24" New Eng.	158	148	6.3	268	249	7.1	1.03	1.04
3¼ x 24" New Eng.	154	144	6.5	261	241	7.6	1.03	1.04
3¼ x 20" Salami	128			216			1.03	
3¼ x 20" Bologna *	144	132	8.3	231	216	6.5	1.09	1.07
3¼ x 20" Bologna *	160	148	7.5	259	245	5.4	1.08	1.05
3¼ x 20" Salami *	152	144	5.2	252	239	5.1	1.05	1.05
3¼ x 20" Salami *	144	136	5.5	238	225	5.4	1.05	1.05
27s x 40 ft. Wieners	179			323			0.97	
27s x 40 ft. Wieners	169			312			0.94	

The difference in weight divided by the change in volume multiplied by the weight of a cu. in. of water gives an estimate of the Apparent Density of the bones removed.

TABLE 4

Meat	Weight	Volume	Apparent density
	oz.	*cu. in.*	
1. Raw ham	184	305.6	1.05
1. Raw ham pumped	205	333.6	1.07
2. Cured ham	178	287.5	1.08
2. Cured ham H bone out	172	280.3	1.07
2. H bone	6	7.2	1.45
3. Cured ham	212	340	1.08
3. Cured boneless	195	321	1.05
3. Body bone	17	19	1.55
4. Picnic bone in, smoked	100	166.7	1.04
5. Picnic bone in, smoked	80	127.8	1.09
6. "Canadian" bacon, cured	106	177	1.04
7. "Canadian" bacon, cured	82	131	1.09

CALCULATING CASING LENGTH FOR GIVEN WEIGHT

The weight of finished piece desired by the packer is usually known. The length of any of the casings listed can be calculated from the data supplied in Table 5. Assuming that he wants a finished bologna of 10 pounds and a slice diameter of about 5 inches, the choice of casing would be the 3¼. The shrink taken in the smokehouse is generally known, too; it is assumed here to be 8%.

160 oz./1.0 — 0.08 = 160/0.92 = 174 oz. green weight bologna.

174 — wt. in sphere of 3¼ casing = 174 — 38.4 = 135.6 oz.

135.6 ÷ wt. per linear in. cylinder = 135.6/11.22 = 12 in. length cyl.

Length cylinder (12 in.) plus stretch diam. (5⅛ in.) = 17⅛ in. piece length. The piece must be tied at both ends. For casings of 2¾ and larger an allowance of 6 in. of casing is made for these ties. This gives us a total casing length of 23 in. The actual amount of casing wasted is about 1½ in. at each end, or 3 in. total. If the contour of the piece is taken as: length of cyl. (12 in.) plus ½ of the stretch circumference (8 in.) we get 20 in. as the contour length of the piece and, adding the 3 in. for ties gives us the same casing length. There is actually a slight longitudinal stretch at the ends of cellulose casings when they are stuffed and when tied, but most of the stretch is due to the transverse stretch of the film as it is stuffed. To find the length of casing for salami meat, the same procedure is followed except the weight of the heavier meat in the sphere and per linear inch of casing is used. In this instance the casing will be an inch shorter.

CONCLUSIONS

With comparatively simple apparatus the Apparent Density of meats can be approximated closely enough so that the data can be used to calculate piece weights in the packing plant. Using the data obtained by this method has given weights and lengths of pieces which checked closely with those found in plant practice.

TABLE 5

High stretch casing	Stretch diameter	Linear inch	Sphere	Linear inch	Sphere	Linear inch	Sphere
	inches	*volumes cu in.*	*volumes cu in.*	*wt. bologna oz.*	*wt. bologna oz.*	*wt. salami oz.*	*wt. salami oz.*
1⅜	2⅜	4.43	7.0	2.42	3.82	2.61	4.13
1¾	3	7.07	14.1	3.85	7.68	4.17	8.32
2¼	3⅝	8.3	18.0	4.51	9.81	4.89	10.62
2¾	4⅛	14.2	40.1	7.73	21.9	8.37	23.66
3¼	4⅝	17.7	56.0	9.64	30.5	10.44	33.0
3¾	5⅛	20.6	79.5	11.22	38.4	12.15	41.6

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As a matter of fact, we started the whole thing in this country. We worked out the means of making glutamates from wholesome, nutritious wheat, the richest natural source of glutamic acid. We've kept on quietly making our taste-improving products; we've grown as the food industries have prospered.

Second, we never thought we'd run pictures of Huron's "founding fathers". Yet here we go — meet Huron's A. Jarvis Patten.

Mr. Patten is the distinguished protein chemist who first worked out the highly complex procedure for making MSG on a commercial scale in this country. If there's ever a Hall of Fame for the food industries, we think you'll agree Mr. Patten deserves a niche there.

A third thing, though, we can't *show* here. That's Huron's wealth of technical experience. Through the years we've built up a technical service group second to none. Having longer experience than any other manufacturer of MSG, we've amassed a vast fund of technical data on its use. The answers to most of the questions processors want to know are in our files right now.

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BOOKS

(Continued from page 18 preceding technical papers)

there are no cumulative indices of the whole. The chapters are numbered consecutively through the two volumes but pages are not. Since this is a first edition some errors appear which will probably be corrected in a future printing. To cite examples: on page 235 of Vol. I the word "hypertonic" is used where *hypotonic* is intended; on page 412 of Vol. II a reference to Greenberg and Larson is given incorrectly as Greenberg and Tufts; and on page 511 of Vol. II the word "dyspnea" is misspelled.

The contributors are British and American specialists in the various fields discussed. Because of this there are marked differences in the style and quality of the chapters and some variability in nomenclature. In Vol. I are included chapters dealing with the history of nutrition, carbohydrate, water and electrolyte, protein, and fat metabolism; the fat-soluble vitamins; the vitamin B complex; vitamin C; and the role of vitamins in blood formation. Vol. II contains histochemistry and histology; the microbiology of digestion; nutrition of invertebrate animals; energy transfer, enzymes and coenzymes; mineral metabolism; and application to human nutrition. Due to the placement of chapters dealing with related subjects both volumes are required for complete reference in many fields of nutrition.

The first chapter is an historical essay on the development of the science of nutrition. In it are lucidly presented the basic theories developed by Lavoisier and his contemporaries and advanced by Voit, Rubner and their successors in the area of metabolism a century and a half later. The second historical section provides a resumé of the vitamins from discovery to current areas of research and is characterized more by brevity than by content. More detailed information is, however, to be found in the discussions of the individual vitamins and application to human nutrition.

Space allotment among the five chapters dealing with metabolism of the major nutrients—water, protein, fat and carbohydrate—is markedly disproportionate. Only sixteen pages are devoted to water and electrolyte metabolism; within this limitation the author elected to give a cursory discussion of the entire subject rather than concomitantly limiting the scope. The chapters on carbohydrate and amino acid metabolism, currently of more popular interest, are more extensive. In the case of carbohydrate, emphasis is placed on the intermediary metabolism and relatively little attention given to physiologic aspects. For example, although the role of the hypothalamus in blood sugar regulation is mentioned briefly, none of the research done in the last ten years is presented. The discussion of amino acids is notable as teaching material, being comprehensive in subject and concise in style. It contains useful tabular material and approximately 800 literature references. Lipid metabolism and the biosynthesis of proteins are also very well done.

The chapters concerning the vitamins are, in general, very good. The discussion of the fat-soluble vitamins is distinctive in that the requirements of several animal species are given. While the B vitamin chapter appears condensed it contains all that is required in view of the

(Continued on page 26)

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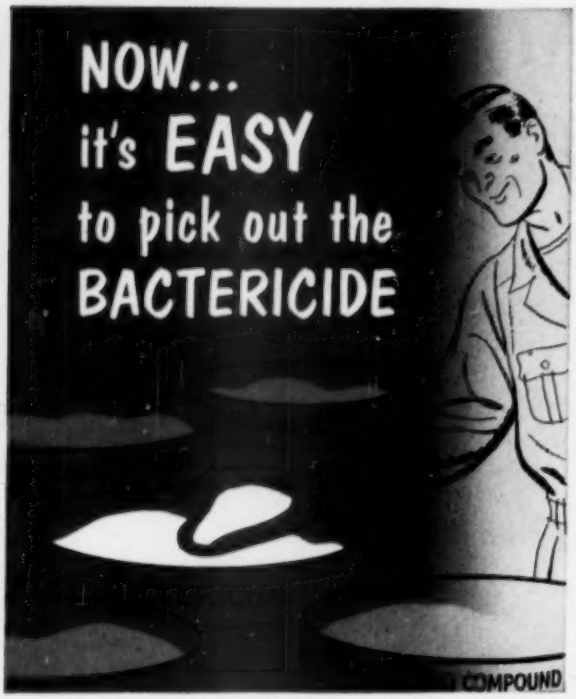

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BOOKS

(Continued from page 24)

fact that an entire section on vitamins and hematopoiesis is included in the same volume and that the enzyme aspects are presented in detail in Volume II. Vitamin C is treated fully and this chapter, like that on amino acids, should be particularly useful in teaching.

The contributions relating to iron, calcium, and phosphorous metabolism are barely adequate, skimming briefly over all the important aspects but not delving into any. The discussion of the trace elements is far superior.

The final section—application to human nutrition—is well done. The approach is more clinical than dietetic and although there is some duplication from other sections, not more than is permissible in a summary.

In Vol. II several topics make their formal debut into nutrition in book form. These are the intracellular localization by histochemical methods of enzymes and vitamins; structural changes in vitamin deficiency; the microbiology of digestion, including discussion of antibiotics and the "germ-free" state; and the nutrition of invertebrate animals. Although some of this material has been given in other texts, this is the first time it has been systematically presented from a nutrition standpoint. The excellent chapters on energy transfer and enzymes are also of more recent interest. These, then, are the chapters that make this book stand out from previous works and, therefore, a valuable reference and useful library addition.

DORIS CALLOWAY,
Chicago, Illinois

SURVEY OF FOOD AND NUTRITION RESEARCH IN THE UNITED STATES OF AMERICA, 1952-53. Prepared by the Food and Nutrition Board, National Research Council, under contract with the U. S. Department of Agriculture. Published by the U. S. Department of Agriculture, Washington, D. C. Printing Office, Washington 25, D. C. Price $1.75.

To record investigative work on food and nutrition under way in the United States between July 1, 1952, and June 30, 1953, requires a volume, approximately quarto in size, of 371 pages. One finds it difficult to refrain from boasting about America's prodigious research energy. The present volume is the third publication in a series initiated in 1947 by the National Research Council through its Food and Nutrition Board. The first volume, published in 1948, was supported by funds granted by the Committee on Food Research, Qm. Food and Container Institute for the Armed Forces. The second edition, a revision of the first, was published in 1950 with financial support from the Food and Nutrition Board, the Quartermaster General of the Army, and the National Canners' Association, and the present volume was financed by a contract with the U. S. Department of Agriculture. The expenditures of money and labor in the production of these surveys are easily defended. They provide a ready means whereby research directors and workers may get in touch with those conducting studies of mutual concern; they provide a source for detecting and eliminating duplication of effort; and they provide a roster of scientific workers out of which task groups for attacks on urgent problems may be

(Continued on page 28)

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BOOKS

(Continued from page 26)

formed. The great value of such a roster for wartime or peacetime purposes is manifest.

The scope of this well-indexed survey can only be suggested here, but the investigations listed include the nutritional requirements of man and animals, digestion and metabolism, nutrition and disease, nutritional status, methodology, enzyme chemistry, food composition and values, food technology (50 pages) and microbiology. The survey also contains a section listing titles for suggested research in the foregoing categories—a most useful appendage for graduate students and instructors.

The information sent in by individuals, colleges, government agencies, members of the food industry, foundations, etc., etc. was compiled and classified by Helen L. Jeffrey assisted by Doris Christensen—a monumental labor, competently done. An advisory committee, consisting of W. C. Russell, chairman, Gladys Emerson, C. G. King, B. L. Oser, and H. E. Robinson aided in the organization of the work and members of the Nutrition Board, L. A. Maynard, chairman, reviewed progress semiannually until the task was complete.

Whether or not this survey will be as widely studied and applied as it deserves to be would be impossible to predict, but a rich opportunity exists for someone to call attention to its resources by analyzing emphases and trends of current investigative work on food and nutrition problems and to attempt to extrapolate therefrom the directions of future research in these fields. The gathering of research forces (28 studies) to understand, isolate, and solve the problems of electronic sterilization would form one very interesting section of such an analysis. There are a dozen others.

MARTIN S. PETERSON
Chicago, Illinois

FUTURE DATES FOR FOOD TECHNOLOGISTS

1954	
August 9-13	Gordon Research Conferences, AAAS, *Food and Nutrition Sessions,* Colby Junior College, New London, N. H.
August 16-20	*Vitamins and Metabolism Sessions,* Colby Junior College, New London, N. H.
August 16-19	National Food Distributors, Hotel Sherman, Chicago, Ill.
August 18-31	Food Show at Cincinnati Zoo, Cincinnati, Ohio
August 30-September 1	Thirty-fourth Annual Convention, American Soybean Association, Memphis, Tenn.
September 12-17	One hundred and twenty-sixth National Meeting of the American Chemical Society, New York, N. Y.
September 13-15	American Fisheries Society, Seattle, Wash.
September 16-18	National Poultry, Butter and Egg Association, Hotel Sherman, Chicago, Ill.
October 1-6	American Bakers' Association, Chicago, Ill.
October 11-16	Dairy Industries Supply Association, Atlantic City, N. J.
November 15-18	International Soft Drink Industry Exposition, Convention Hall, Philadelphia, Penna.
June 12-16, 1955	**Institute of Food Technologists, Deshler-Hilton Hotel, Columbus, Ohio**

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)

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Terminal Island, Calif.

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Standard Brands Inc.
595 Madison Ave.
New York 22, N. Y.

Margaret L. Buch
Eastern Util. Res. Branch
Philadelphia 18, Pa.

Manley W. Cole
133 Orchard Lane
Upland, Calif.

William J. Colman
Marrickville Margarine Pty. Ltd.
Box 4, P. O.
Marrickville, N.S.W., Australia

Leslie C. Davis
P. O. Box 3
So. Melbourne, Vic., Australia

David L. Estes
Libby, McNeill & Libby
Ocala, Florida

Dr. Laura M. Flynn
105 Schweitzer Hall
Dept. of Agr. Chem.
Univ. of Missouri
Columbia, Mo.

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Hercules Powder Co.
3460 Wilshire Blvd.
Los Angeles, Calif.

David A. Halgren
669 E. Bonnie Brae Ct.
Ontario, Calif.

Richard C. Harrell
821 E. 116th St.
Hawthorne, Calif.

Lionel F. Hawkins
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Blakehurst, N.S.W., Australia

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P. O. Box 3
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Aaron B. Karas
Dept. of Dairy Industtry
Univ. of Massachusetts
Amherst, Mass.

Larbee W. Petros
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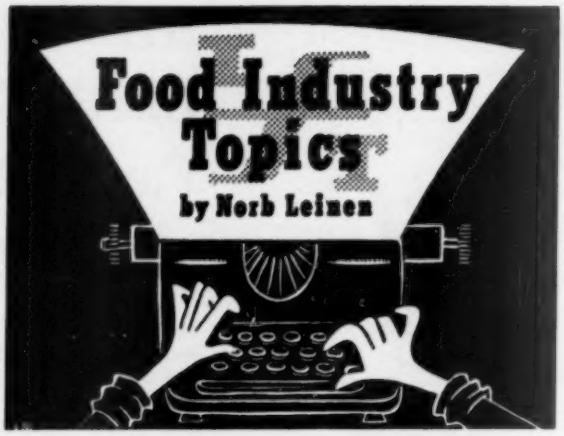


. . . in the public interest

More than two million Americans who will not or cannot eat ice cream will soon be able to buy a close substitute that has only about a third of the fat and little more than half the calories of ice cream. Called "frozen dessert," the substitute has been developed by University of Illinois dairy technologists Samuel Lombard and P. H. Tracy. Since about 30% of the solids are taken out when the sugar is removed and sucaryl substituted, a protein of animal source is substituted for the carbohydrates in frozen dessert. Flavor is achieved by using sugar-free extracts such as maple, mint, vanilla, and coffee. The finished product, while not an exact duplicate of ice cream, is pleasing enough to serve as an excellent replacement. Grant for the research came from the Abbott Pharmaceutical Laboratories, Chicago.

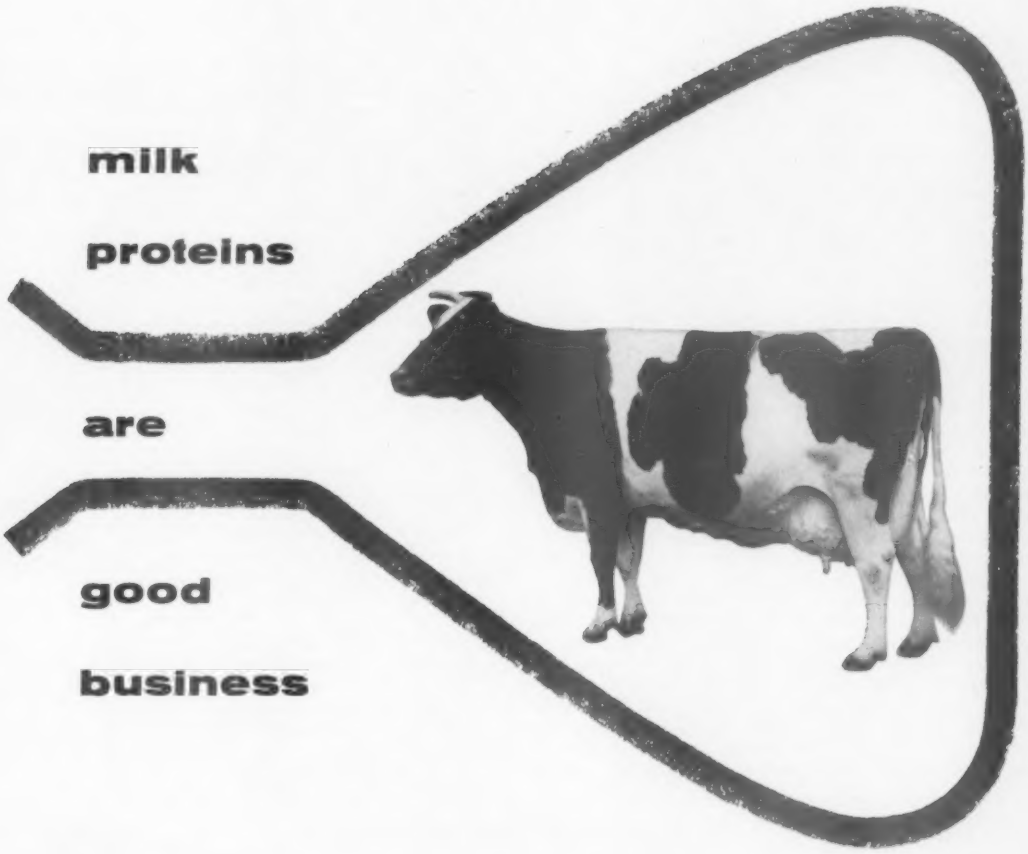
◆ ◆ ◆

"It's time someone made the point that invention of atomic energy is not a disservice to humanity, that knowledge for the sake of knowledge is always good, and that scientific progress always hurts—but it always hurts fewer than it helps, and leads to better lives for all of us," orates the *York Report* in its May issue. Published by York-Gillespie Mfg. Co., 39th St. and Alleghany Valley R.R., Pittsburgh 1, Pa., the *Report* recognizes the preservation of foods with atomic radiation as the most promising present development. "Imagine," it says, "steaks, roasts, and other cuts of meat kept at room temperature for years and as tasty when served as they were the day the meats were cut and packaged! Think of fruits and vegetables with the deliciousness that only country-dwellers now know. This may be possible if fruit can be irradiated and sealed air-tight right in the field. Dream of ripe tropical fruits on your breakfast table in the middle of winter, brought from the other side of the world not by costly air transportation but by slow and inexpensive freight!" The *Report* observes that many experiments in the preservation of food have been disappointing—that some irradiated foods have off-colors and off-flavors, and that some have lost vitamins. "Do not confuse disappointment with discouragement," the *Report* concludes. "To the true scientist, each disappointment is another challenge!"

◆ ◆ ◆

Expansion of the Food, Confectionery & Dairy Division of the Committee of American Industry was announced recently by its chairman, Mr. Geo. H. Coppers, president of National Biscuit Company. The Committee of American Industry, comprising 60 trade divisions, is an arm of the National Fund for Medical Education which has set an annual goal of $10,000,000 for the support of the nation's 79 medical schools. Objective of the program is to obtain corporate support for the medical schools—so that they may escape the alternative of federal subsidies. Mr. Colby M. Chester, honorary chairman of General Foods Corp., is chairman of the CAI. Mr. Coppers said that the following corporation heads have agreed to join with him and other leaders in the food, confectionery, and dairy industry to meet the medical schools' needs: W. H. Albers, Albers Super Markets, Inc.; Chas. H. Bell, General Mills, Inc.; J. S. Elli-

(Continued on page 32)



Today, the public is becoming more and more aware of the need for lower calorie, tissue building, higher protein containing foods for everyone, particularly grownups and the ever-expanding old-age groups. Processors of food products can cash in on this interest by increasing and improving on the protein content of their products with Sheffield milk proteins.

Ice cream, baking, cereal, infant food and meat processors are finding milk proteins a highly desirable supplement to their products. Nature has built extra values into milk proteins, and Sheffield brings these extra values to you. As an example, Sheffield milk proteins are outstanding in nutritional quality because of the fine balance of all essential amino acids.

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FOOD INDUSTRY TOPICS

(Continued from page 30)

thorp, Jr., Beech-Nut Packing Co.; Paul S. Gerot, Pillsbury Mills; T. P. Heffelfinger, Van Dusen Harrington Co.; R. G. Lucks, California Packing Corp.; Kenneth F. MacLellan, United Biscuit Co. of America; John C. Naylor, Pet Milk Co.; R. P. Noble, Life Savers Corp.; Daniel Peterkin, Jr., Morton Salt Co.; Ange Q. Petersen, Wesson Oil & Snowdrift; Dr. Ernest W. Reid, Corn Products Refining Co.; Chas. Ritz, International Milling Co.; Robert B. Smallwood, Thos. J. Lipton, Inc.; Frederick W. Specht, Armour & Company; W. C. Stolk, American Can Co.; E. H. Stuart, Carnation Co.; R. C. Wagner, Clinton Foods, Inc.; Lingan A. Warren, Safeway Stores, Inc.; and J. M. Wilkerson, Nashville Pure Milk Co. For further information on the work of the Committee, write Mr. E. J. Ade, public relations and fund raising director, National Fund for Medical Education, 2 W. 46th St., New York 36, N. Y.

◆ ◆ ◆

"Millions in the Far East and in Latin America are underfed, but there are 25,000,000 in this country who are just as badly off from a health standpoint because they have laid on too much hog fat," stated Dr. Charles G. King, discoverer of vitamin C and now director of the Nutrition Foundation, during a recent public lecture in Columbia University's McMillin Academic Theater. He found the status of US nutrition good in the sense that we are the best fed people in the world, but bad insofar as we eat too much and pay too much attention to the advice of food faddists. "The food faddists and quacks who decry our modern escape from the good old days when every household milked cows, kept chickens and pigs in the back yard, made sauerkraut on the side porch, and stored a year's supply of grain in the barn loft are either grossly ignorant or outright dishonest," he declared. Though we are well off so far as abundance of food is concerned, Dr. King is not content with the way food is selected and used and advocates better public education with regard to such corrective menu items as enriched cereals, vitamin D milk, and frozen vegetables. Dr. King stressed the need for more research to determine the role of nutrition in overcoming degenerative and deficiency diseases, much as similar studies have helped bring once highly feared infectious diseases under control.

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To meet the need for **rapid and accurate detection of alterations in chemical and physical properties of substances**, the Chemical Institute of Zurich, Switzerland, offers the Drage Viscometer, available in the US through Drage Products, 406 32nd St., Union City, N. J. Embodying several outstanding features, the Drage Viscometer has especial applications in industries where the homogeneousness of the final and the intermediate products are required. For further information, write to Drage Products at the above address. Demonstrations are arranged upon request.

◆ ◆ ◆

A remarkable **substitute for garlic oil** has been perfected by Florasynth Laboratories, Inc., 205 E. 42nd St., New York City. The substance—an unsaturated sulfide compound—is reportedly an amazingly close reproduction of the natural flavor characteristics of pure garlic oil, yet is available at unusually low cost. Full information on this new Artificial Garlic Oil is available

(Continued on page 34)

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For fish... Ascorbic Acid prevents "rusting" of the fatty portion... preserves natural colors ...cuts atmospheric oxidation, source of rancidity and strong, unpleasant taste. In both fruits and fish, Pfizer Ascorbic-Citric Mixtures give the same effective control of oxidation *at much lower cost.* For more information about Pfizer antioxidants call or write...

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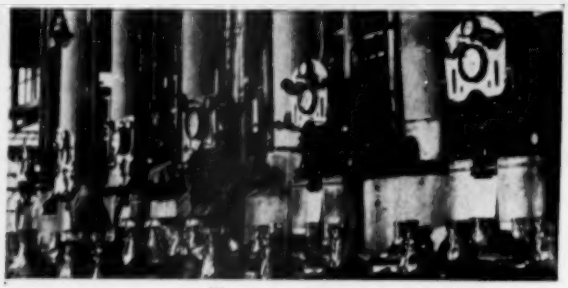

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As a primary source of supply for flavor materials, Givaudan, the world's largest producer of aromatics, has played a dominant role in the development of flavoring science.

We offer you a complete line of flavors for confectionery, ice cream, bakery and other products—all skillfully created to lend true taste appeal. At your request, our flavor staff will study your individual problem and make recommendations from hundreds of proven Givaudan flavors. Or we will develop an individual creation to meet your specific needs. Make Givaudan your flavor headquarters.

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FOOD INDUSTRY TOPICS

(Continued from page 32)

by writing on company letterhead to Florasynth offices throughout the country or to the New York headquarters. Price is $54.00 per pound, with trial quantities available at $4.00 per ounce.

◆ ◆ ◆

Specially heat-stabilized Polyethylene filter cloth which minimizes shrinkage from temperature effect alone up to 212° F. is available from The National Filter Media Corp., New Haven 14, Conn. The cloth is also resistant to most acids, the common alkalis, certain organic solvents and oxidizing agents, most aqueous salt solutions, and mineral and vegetable oils, as well as attack from molds, mildew, moths, and sunlight. Moisture absorption factor is less than 0.01%.

◆ ◆ ◆

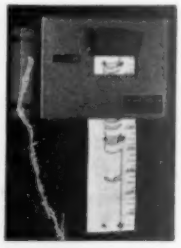
Stock design vignettes for frozen waffles are the newest creation of Western Waxed Paper Div., Crown Zellerbach Corp., San Leandro, Calif. Other stock designs include those for frozen meat, poultry, vegetables, fruits, sea food, and popular specialties. Printed in full color on the company's patented Glosseal stock, the new waffle vignette will be supplied for use on two sizes of waffle cartons — 6 x 4¼ x 1 15/16" and 6⅛ x 4⅛ x 1⅞".

◆ ◆ ◆

Food industry workers may now enjoy the safety of a new **surefooted sole tread** designed for work on the wet, oily flight decks of aircraft carriers. A patented design of multiple concentric circles molded in rubber, the tread grips with a squeegee action and provides excellent traction on wet, icy, or oily surfaces. Further information on this anti-slip footwear is available from Fellman Tri-Vac Footwear Inc., 19 W. 44th St., New York City.

◆ ◆ ◆

Industries can have a **continuous check on their process systems and equipment** by using the Time-Recorder-Totalizer or the Time-Totalizer—two new products manufactured by the Heat-Timer Corp., 657 Broadway, New York 12, N. Y. The former instrument is designed for those wanting an uninterrupted record of when and how equipment is used. On a continuous tape, a permanent record shows chronologically when the process or equipment is on or off, and highlights defects in the process, equipment, or automatic control adjustment used in the system. In addition to the tape recording, total operating time is totalized automatically in a manner similar to the mileage meter of an automobile. The other new product, the Time-Totalizer, automatically totals equipment operating time. Both items are tamperproof.



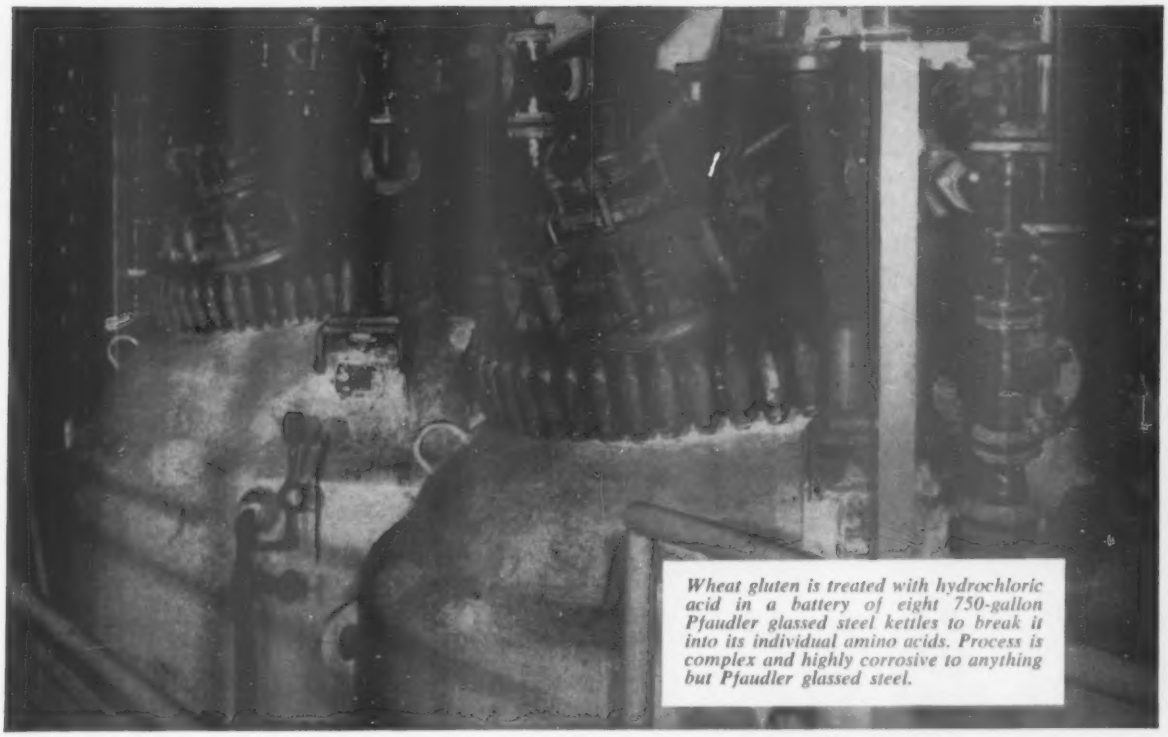
◆ ◆ ◆

Du Pont **cellophane** will be available in greater quantities by year's end, according to company announcement. Projects now in progress, involving modernization of equipment and application of the latest technology in cellophane manufacturing, are expected to result in additional annual productive capacity of approximately 25 million pounds of cellophane by Fall 1954. In addition, improvements in process control are expected to bring corresponding improvements in quality. Du Pont manufactures cellophane at plants in Buffalo, N. Y., Old Hickory, Tenn., Richmond, Va., and Clinton, Iowa.

. . . *the human element*

Mr. Miguel Romero, one of Mexico's outstanding young chemists, and present holder of the Camille and Henry Dreyfus Foundation Fellowship at Harvard University, has received the unusual distinction of a second one-year extension for further study. The additional year will permit Mr. Romero, a staff member of the Instituto de Quimica, to complete his program of graduate study and research leading to a Ph.D. degree. The Camille and Henry Dreyfus Foundation was founded by Dr.

(Continued on page 36)



Wheat gluten is treated with hydrochloric acid in a battery of eight 750-gallon Pfaudler glassed steel kettles to break it into its individual amino acids. Process is complex and highly corrosive to anything but Pfaudler glassed steel.

To keep monosodium glutamate pure, they digest the wheat . . . not the equipment

If corrosion destroys *your* processing equipment, get this protection

The fact that HCl will digest just about everything except glass makes HCl and Pfaudler glassed steel natural partners in the manufacture of monosodium glutamate.

In making MSG, wheat gluten has to be hydrolyzed with HCl—and no manufacturer wants to contribute part of his equipment to each batch. Corrosion of equipment is costly, and dissolved metal contributes nothing to a product's purity or profitability.

Pfaudler glassed steel reactors make possible accurate control of the digestive process without the complicating dangers of metallic intrusion which can destroy flavor, color, or purity. Pfaudler glassed steel gives you the chemical resistance, the cleanliness, and the smoothness of glass with the strength of steel.

So if corrosion is destroying *your* processing equipment, Pfaudler glassed steel offers the best protection for the least money. This glass is resistant to all acids (except hydrofluoric) and alkaline solutions (up to pH 12 at 212° F.). Fused to steel for strength, no other material compares with it on a service-price basis.

Standard equipment is available for heat exchange, cooking, cooling, mixing, concentration and storage for a wide diversity of processes. It also can be engineered to your specific needs. To bring yourself completely up to date on Pfaudler glassed steel, mail the coupon for Bulletin 902.

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FOOD INDUSTRY TOPICS

(Continued from page 34)

Camille Dreyfus, chairman of Celanese Corporation of America, who perfected the chemical process for cellulose acetate.

◆ ◆ ◆

Mr. Robert E. Pence has been appointed to the Midwest sales staff of Huron Milling Co., 9 Park Pl., New York City. Mr. Pence, a graduate of Florida State University and formerly with Unified Underwriters, Inc., Indianapolis, Ind., will service customers for MSG (monosodium glutamate) and HVP (hydrolyzed vegetable protein), Huron's nationally advertised taste boosters, in the states of Indiana, Illinois, Iowa, Missouri, and Kentucky.

◆ ◆ ◆

Mr. Pence

Mr. Kretlow

Mr. Wilbur Kretlow has been elected vice president of the Wm. J. Stange Company, in charge of the Certified Food Color Division, it has been announced by **Mr. Wm. B. Durling,** president. Mr. Kretlow, with Stange since 1927, is well known throughout the food processing industry and has published many articles on the production and application of certified food colors.

◆ ◆ ◆

Mr. George F. Henschel, manager of sales for American Can Company's Atlantic Division, has been named general manager of sales in the company's general offices in New York City, according to announcement by **Mr. D. B. Craver,** vice president in charge of sales. A veteran of 24 years with the can-making firm, Mr. Henschel had held his most recent post since December 1952.

◆ ◆ ◆

Mr. Henschel

Mr. Nester

Mr. Jos. M. Nester was elected president of the Glass Container Manufacturers Institute, Inc., at the Institute's 10th annual meeting on May 18. Mr. Nester is president of Obear-Nester Glass Co., one of the 78 manufacturers of glass bottles, jars, closures, and supplies comprising the Institute's membership. For the coming year, he will head an association whose members now produce an all-time high of more than 19 billion glass jars and containers a year. The industry output represents an annual total of 112 glass containers for every man, woman, and child in the nation.

. . . *the literary corner*

"Analytical Services," an illustrated eight-page booklet issued by Foster D. Snell, Inc., consulting chemists and engineers, describes the firm's services in the analysis of drugs and pharmaceuticals, samples from shipments, materials according to specifications, foods (for detection of harmful contaminants), and samples involved in litigation. The booklet points out that analytical research is undertaken in cases where there are no published methods. The new techniques of spectrophotometry, spectrography, flame photometry, polaragraphy, chromatography, and radiochemistry are generally employed. For booklet and further information write Mr. Shepherd Stigman, Public Relations Dept., Foster D. Snell, Inc., 29 W. 15th St., New York 11, N. Y.

◆ ◆ ◆

Sindar Corporation, 330 W. 42nd St., New York 36, N. Y., has just published a supplemental bibliography of articles on G-11[R] (Brand of Hexachlorophene) in the *Sindar Reporter* No. 2—1954. The bibliography contains abstracts of articles which have appeared since publication of Sindar Corporation's technical bulletin H-1 entitled, "G-11[R] (Hexachlorophene), an annotated bibliography," May 1952. This is the second supplement to this bibliography, the first having been published in *Sindar Reporter* No. 4—1953. Copies of both the full bibliography and both issues of the *Sindar Reporter* containing the supplemental bibliographies are available upon request.

Trends in the essential oil market are noted in the May *Market Report* of E. Ritter & Co., 4001 Goodwin Ave., Los Angeles 39, Calif. (mail address: P.O. Box 12696, Los Angeles 39, Calif.). According to the *Report,* peppermint oil should continue to advance in price until the new crop becomes available in late Fall. Other essential oils which require close watching are lemon-grass, dillweed, and lime. Mexico is one of the world's principal suppliers of lime oil, and trade observers do not believe a decline in price will follow the devaluation of the Mexican currency. California lemon has declined in price due to Italian competition, but California orange is stable at prevailing prices. The continued price decline of oil of clove over an extended period is believed to be at the bottom of its cycle.

◆ ◆ ◆

The effects that varying temperatures and humidities have on moisture and temperature-sensitive cellophane, and the air conditioning systems and equipment used successfully to protect cellophane in storage and process at Milprint, Inc., are described in an article by Mr. Donald P. Garry, sales manager, Dairy Packaging Div., Milprint, Inc., which appeared in the March 1954 issue of *Flow.* Article reprints are available from Mr. R. C. Wayne, advertising manager, Industrial Division, Surface Combustion Corporation, Toledo 1, O.

◆ ◆ ◆

Pamphlet FM-2, published by the Central Scientific Company, 1700 Irving Park Rd., Chicago 13, Ill., summarizes moisture methods in foods, food products, insecticides, and fungicides following the official methods of the Association of Official Agricultural Chemists. Also included is detailed information on the determination of moisture in many food products using the Cenco Moisture Balance. The data was reported by laboratory personnel in the food industry who made many determinations with the instrument in the laboratory before putting it into routine use.

◆ ◆ ◆

The most comprehensive editorial treatment ever accorded the subject of demineralization in a company publication is contained in a new, 24-page Bulletin WC-111, now available from Graver Water Conditioning Co., 216 W. 14th St., New York 11, N. Y. Chemical and mechanical factors entering into the design and operation of demineralizing plants for obtaining the highest quality process water and boiler feedwater from a wide range of water supplies and under many different operating conditions are fully explained. How the removal of ionized, dissolved solids from water by means of ion exchange assures trouble-free operation of many types of equipment, and how it aids in the improved manufacture of many products, including foodstuffs, is described. The application of demineralizing to low-makeup and high-makeup boiler plants is also explained.

FOOD INDUSTRY TOPICS

Features and specifications of the de luxe, standard, and industrial models of the JAco Varisource, the all-in-one excitation unit for precision spectrochemical analysis, are covered in a new eight-page catalog No. V3-54, published by Jarrell-Ash Co., 26A Farwell St., Newtonville, Mass. Special design features which make the Varisource unmatched for stability, reproducibility, versatility, and ease of operation are described. Tables give relative qualities and parameter specifications of the five types of excitation circuits available. The JAco Varisource is for use with prism or grating spectrographs of any make.

◆ ◆ ◆

From Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y., comes a new brochure, "How the D&O Laboratories Serve You," covering the many services available from the firm's enlarged technical staff working in recently expanded laboratory facilities. As the booklet points out, in the Perfume, Industrial Odorant, Aerosol, Flavor, and Dry Soluble Seasonings Product Development Laboratories, trained chemists are constantly at work upon individual and specific problems submitted by D&O customers . . . while the Organic Research and Analytical Laboratories seek to develop new aromatic chemicals for the entire industry and exercise a strict system of quality control.

◆ ◆ ◆

A spate of literature from Minneapolis-Honeywell includes the following: Catalog No. 5001, Honeywell's revised Composite Catalog, containing brief descriptions of all Brown Instruments; Catalog 2320, describing all types of flow meters made by the firm's Industrial Division; Bulletin 6430, describing the new Brown dual temperature controller which incorporates two complete systems for measuring, indicating, and controlling two temperatures; Bulletin 9050, "Instrumentation for Steam Generation," which provides a convenient, one-source reference for all products of Honeywell's Industrial Division applicable to steam generation; and Specification Sheet 165.1, containing information of two new electronic strip chart recording instruments designed to record 10 and 20 points and which are particularly suited for such installations where a quantity of information is required but where measurement is limited either by cost or space considerations. In addition, Alphabetical Index 200-C covers all issues of *Instrumentation*, the company's external publication, published from 1943 through 1953. The index is a valuable key to many technical articles on industrial instrumentation, articles describing actual plant installations, as well as those dealing with instrument maintenance and the organization and training of instrument departments. For any of the above literature write: Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Aves., Station 64, Philadelphia 44, Pa.

◆ ◆ ◆

A quick connect-disconnect hose coupling for water, oil, steam, gas, and chemical lines which provides permanent freedom from leakage is described in a bulletin just published by Titeflex, Inc., Hendee St., Springfield 4, Mass. Entitled "Titeflex Quick-Seal Coupling," the 16-page booklet describes the simple construction of the coupling and points out how this construction provides (1) a unique sealing action which makes the coupling tighter as internal pressure increases, and (2) a full swiveling action that prevents hose twisting and kinking. Also described are single- and double-check valve modifications of this coupling. For copies write to Industrial Sales Division at the above address.

◆ ◆ ◆

A four-page illustrated bulletin describing "Infralite," the new radiant heater which provides more than 100 watts per square inch of lamp surface, has been released by the N. J. Thermex Co., 535 Bergen St., Harrison, N. J. The bulletin describes how "Infralite" can cut production time to a fraction of other methods of drying, baking, heating, etc. Standard "Infralite" electric radiant heaters range in size from 6 to 72 inches in over-all length, 100 to 10,000 watts, and 115 to 230 volts.

◆ ◆ ◆

The latest edition (May-August 1954) of the new king-size catalog published by Magnus, Mabee & Reynard, Inc., international essential oil firm, presents the company's extensive research and control facilities in pages of pictures. Working in finely equipped modern laboratories, the MM&R research staff is constantly developing new perfume bases and flavor materials for use in more than 60 industries in all parts of the world. Another interesting innovation is "What's New—For You?" which focuses attention on important new MM&R products. For a copy address Magnus, Mabee & Reynard, Inc., 16 Desbrosses St., New York 13, N. Y.

◆ ◆ ◆

Complete details, specifications, and illustrations on International Staple Prince stapling machines are now available in a new product bulletin, No. P/401, published by International Staple & Machine Co., 801 Herrin St., Herrin, Ill. The machines handle simultaneous closing of both ends of full overlap and telescope cartons, either corrugated or fiber board. Carton height, width, length, and weight, plus variations in stapling heads to fit packaging requirements, is explained. The manufacturer has outlined the conveyor operation with an explanation of the various conveyor tables that may be designed for different uses and types of operation.

◆ ◆ ◆

Among the rewarding articles in the May 1954 issue of *Industrial Bulletin*, published by Arthur D. Little, Inc., Cambridge, Mass., is one entitled "Success Pools," which delves into current efforts directed toward recovering vitamin B_{12} and other feed supplements from municipal sewage. Such nutrients would be in addition to the fertilizer products already recovered from sewage in various municipalities. The article describes pilot plant work in Milwaukee, Chicago, and Battle Creek, Mich., and points out that large-scale production awaits investigation of the market potential of these materials as supplements in animal and poultry feeds.

. . . *building up and branching out*

Controlling interest in **Morris & Martin Ltd.**, an engineering and manufacturing firm located in Port Elizabeth, South Africa, has been acquired by Food Machinery and Chemical

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Corp., San Jose Calif., according to announcement by FMC officials. The South African firm offers engineering services in the mechanical, irrigation, and marine engineering fields and operates a plant that produces machinery for South Africa's pineapple canning industry. Plans for construction of a new manufacturing plant are now under way. The rapid expansion of the South African peach, pineapple apricot, pear, and citrus industries indicates an increasing market for FMC fruit and vegetable canning machinery and citrus packing house equipment, states the San Jose firm. Present plans indicate that the new subsidiary will continue under its present management.

◆ ◆ ◆

A **new German emulsifier company,** Atlas-Goldschmidt, G. m. b. H., has been formed jointly by Atlas Powder Co., Wilmington, Del., and Th. Goldschmidt, A.-G., Essen, Germany, it was announced recently by Atlas president, Mr. Ralph K. Gottshall. Beginning July 1, the new enterprise will undertake a broad program of product research and development and will market surface-active agents and emulsifiers throughout Europe and other parts of the world. Appointed managers of the new organization are Dr. Hans Dohse and Mr. Heinz B. Tillman, both long active in the German chemical industry. In addititon to the new German affiliate, Atlas also jointly owns Atlas Powder Co., Canada, Ltd., which is building an emulsifier plant in Brantford, Ont. Atlas' domestic emulsifier operations are being expanded by the erection of a plant in Memphis, Tenn. The company's surfactant production currently is centered in its Atlas Point plant near Wilmington.

◆ ◆ ◆

The Foxboro Company, Foxboro, Mass., is building a **new branch factory** at 399 Preda St., San Leandro, Calif. Scheduled for completion by August 15, the new 8400 square foot building will more than double the production area of the present San Francisco shop and provide increased facilities for the manufacture, sales, and service for the firm's line of industrial instruments and accessories for process measurement and control. A new Dallas factory, recently completed, now serves industries of the South and Southwest. In addition, a site has been selected and construction started for a new Pittsburgh plant.

. . . *meeting hall and conference room*

Loss and damage claims against American railroads in 1953 amounted to more than $111,000,000—mostly caused by little, common, everyday faults that can be corrected with proper study. This was pointed out by Mr. C. A. Naffziger, Association of American Railroads, Chicago, at the April 26-28 **Conference on Transportation of Perishables** held at the University of California, Davis. Among the many papers presented were several on latest developments in the handling of citrus fruits, one on electronic color sorting of fruits, several on the work of railroad inspection agencies, and two on trends in the fields of transit refrigeration. Participants included representatives of the railroads, fruit processers and distributors, University of California researchers, and experts from the California Department of Agriculture. For more detailed information on the Conference papers, contact University of California, College of Agriculture, Berkeley 4, Calif.

◆ ◆ ◆

New techniques in manufacturing and processing was the theme of the **Kenilworth Klinic,** sponsored by the Kenilworth Steel Co., Kenilworth, N. J., to stimulate thinking in production methods, packaging, finishing, and warehousing. Featured on seven of the ten heavy machinery exhibits was the Leveling Barrymount, a device which prevents "walking" and which levels and isolates machinery from shock and vibration without bolting to the floor. Manufacturer is The Barry Corp., Watertown, Mass.

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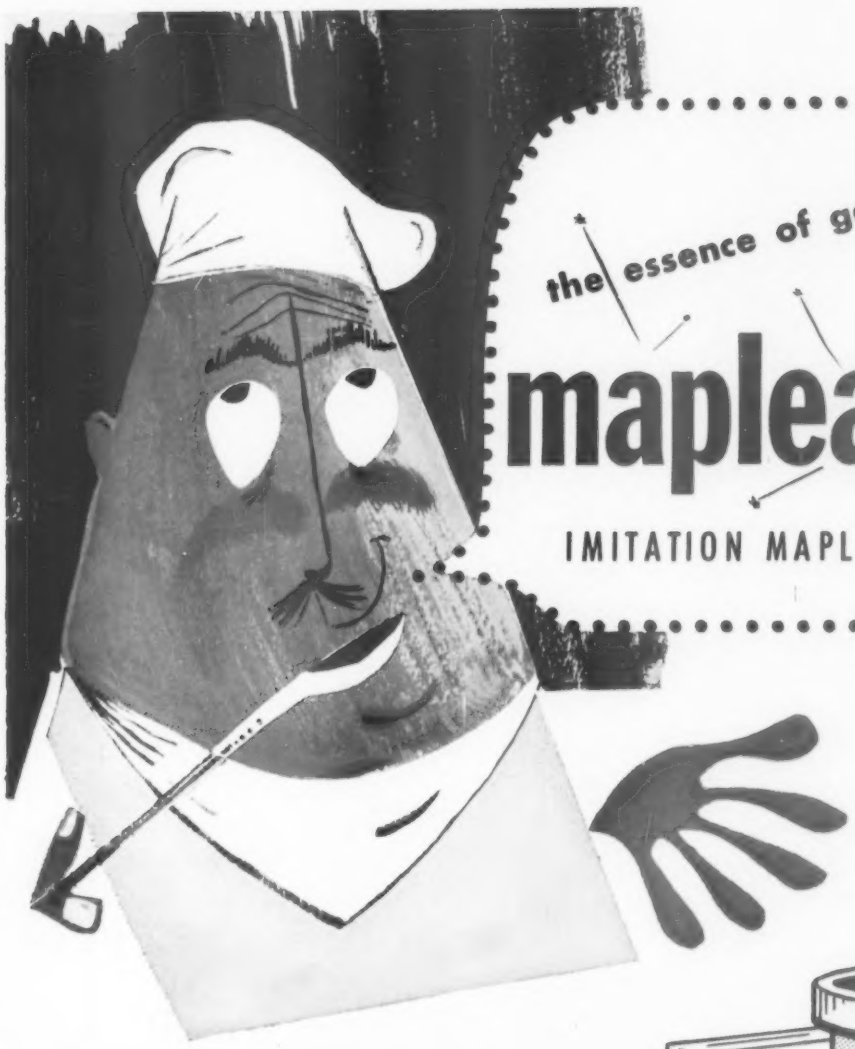

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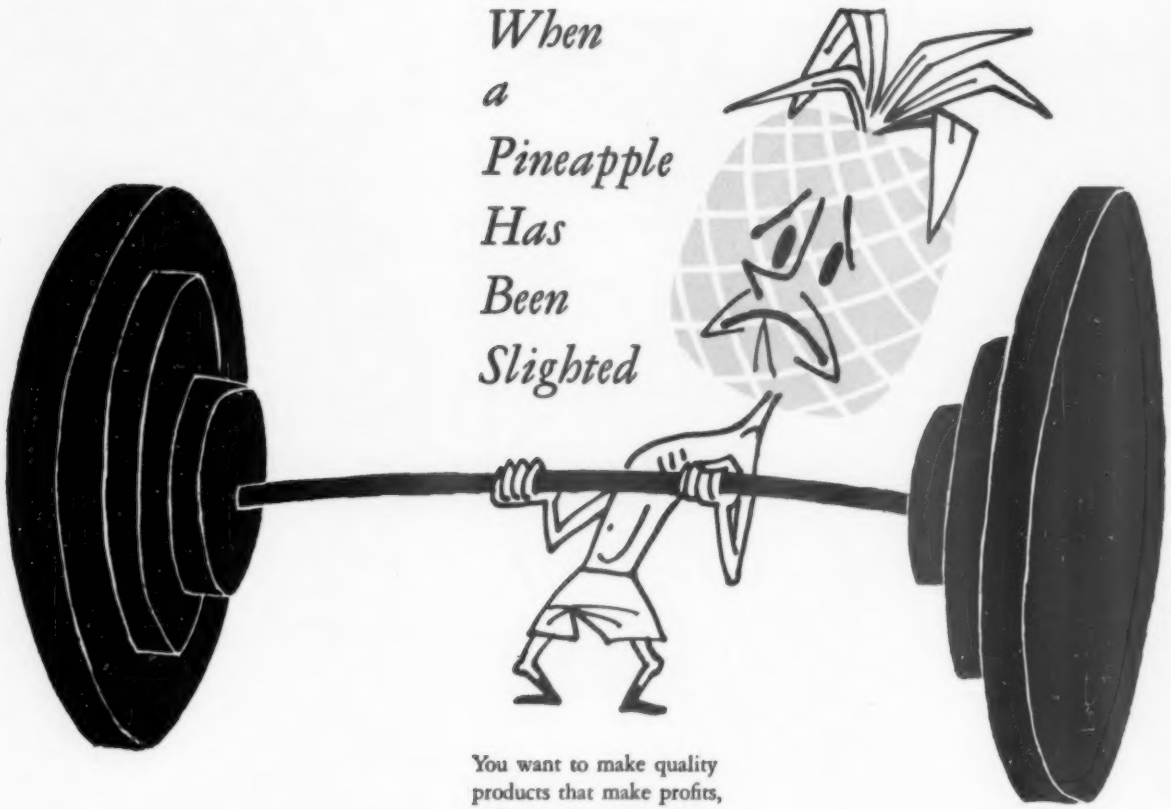

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